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INFLUENCE OF EXCISION AND GROWTH SOLUTIONS ON POTASSIUM INFLUX INTO ROOTS OF RICE AND WHEAT SEEDLINGS UNDER ACIDIC STRESS

F. Zsoldos and A. Bérczi

(Received: April 22, 1985)

Abstract

Responses of intact and excised roots of rice (*Oryza sativa* L. cv. Dunghan Shali) and winter wheat (*Triticum aestivum* L. cv. GK Szeged) to low pH stress in K^+($^{86}Rb^+$) influx were studied and compared. Excised rice roots grown in 0.5 mM $CaSO_4$ solution show an increased (anomalous) K^+ influx responding to H^+ stress (pH 3). Such an influx anomaly, however, was not detected in intact roots of rice seedlings grown in full nutrient solution. In the case of wheat seedlings, the K^+ influx anomaly was not observed. Strictly speaking, the K^+ influx anomaly could be detected only in case of „stress-sensitive" plants (e.g. rice) grown under insufficient ionic conditions (e.g. in 0.5 mM $CaSO_4$), and if excised roots were used for K^+ influx experiments. In conclusion we emphasize that results obtained with excised roots of stress-sensitive plants grown in 0.1–0.5 mM $CaSO_4$ or $CaCl_2$ solutions do not apply to intact plants, whereas stress-resistant plants (e.g. wheat) do not seem to have such K^+ influx problems.

Key words: Ca^{2+}, K^+, influx anomaly, pH, stress sensitivity

Introduction

Various physiological changes influence the enhancement of ion uptake resulting from excision and washing or aging (Ferrari and Renosto, 1982; Jacobson and Young, 1975; Leonard and Hanson, 1972; Parrando and Smith, 1976). In spite of the fact that this issue is very interesting from many aspects, we do not know enough about the mechanism causing this effect. There are conflicting reports in the literature concerning the effects of excision on ion uptake (Cseh, 1974; Frick et al. 1977; Frick, 1980). Several authors state that the enhancement of ion uptake as a consequence of root excision is due to injury followed by recovery (Glass, 1978; Gronewald et al. 1979; Jacobson and Young, 1975). The enhancement of ion uptake associated with aging in excised root tissues is thought not to be detectable in fresh excised roots (Glass, 1978).

Growth conditions also influence the ion uptake processes. As for the ionic state of plants, it has been shown that winter wheat seedlings grown in 0.5 mM $CaSO_4$ solution resembled to seedlings grown in tridistilled water rather than to the plants grown in K^+-less nutrient solution (Bérczi et al. 1984a,b). It is not yet known, however, how the components of the ionic state of the plant influence ion uptake.

The experiments described below were conducted as part of a continuous study of regulation of K^+ uptake in response to low pH stress. We noted earlier that excised primary roots of low salt rice seedlings responded to H^+ stress by increased

K^+ uptake and decreased K^+ content, suggesting an increased anomalous exchange between the cytoplasmic K^+ pool and the external medium (ZSOLDOS and ERDEI, 1981). Our earlier data also showed that under acidic stress conditions excised roots underwent changes in plasma membrane composition and structural organization (ERDEI et al. 1981; BÉRCZI et al. 1981), resulting in K^+ anomaly and leakage. To understand the anomaly more deeply, further K^+ uptake experiments were performed with excised roots as well as with intact plants of rice and winter wheat seedlings under acidic stress conditions.

Materials and methods

Rice (*Oryza sativa* L. cv. Dunghan Shali) and winter wheat (*Triticum aestivum* L. cv. GK Szeged) seeds were washed in running tap-water for 4–6 h and then germinated in Petri dishes for 2 days (rice) or one day (wheat) at 24 °C. After germination the seedlings were cultured in 0.5 mM $CaSO_4$ or diluted full nutrient solution (0.5 mM $CaSO_4$, 0.1 mM KH_2PO_4, 0.1 mM NH_4NO_3, 0.1 mM NaCl, 0.1 mM $MgSO_4$, micro nutrients as in BÉRCZI et al. 1982) in a Conviron phytotron (Cabinet Model EF7), under about 80 Wm^{-2} light intensity and 16 h photoperiods. The relative humidity was about 75% and 60% for rice and wheat, respectively. The day/night temperature was 24/20 °C.

The plants used in the K^+ uptake experiments were germinated for 7 days (rice) or 5 days (wheat), when their roots were about 7 cm long. In K^+ influx experiments $^{86}Rb^+$ was used as label for K^+. The influx experiments were performed at room temperature in 1 mM KCl solution in the absence or presence of 1 or 10 mM $CaCl_2$. The specific activity of the uptake solution was 555 kBq.(mmol K)$^{-1}$. The amount of isotope taken up by the roots was measured with a γ-spectrometer counter (Gamma NK-350, Hungary). The pH of the uptake solution was adjusted to the appropriate value with 0.1 M HCl and they were also tested after the influx experiments lasting 1 h. Roots were excised within 10 min before the beginning of experiments. At the end, roots were rinsed three times in 400 ml distilled water for 1 min. There was no any essential difference between the results when rinsing had been performed either in tridistilled water or in inactive uptake solution.

In every series of experiments triplicate samples were measured. The deviations between the results from individual determinations were less than 10% of the arithmetical mean value. Potassium and calcium contents of roots were determined as described earlier (BÉRCZI et al. 1982) both before and after the K^+ influx experiments.

Results and discussion

Ion uptake of roots can be studied either with excised roots or with roots of intact seedlings (intact roots). They represent two different conditions in uptake experiments. Potassium influx (or uptake) of roots has been studied mostly with low K roots. To obtain such roots, plants had to be grown either in 0.1–0.5 mM $CaSO_4$ or $CaCl_2$ solution or in diluted complete nutrient solution. These treatments represent two different conditions for growth. In spite of the fact that these growth conditions result in nearly similar low K roots, the ionic state of the roots, which involves not only the K content but also the Na, Mg and Ca content, do differ (BÉRCZI et al. 1982, 1984a,b). The two-times-two different conditions allow us to study the pH-dependent anomalous K^+ influx of roots under four circumstances.

The pH-dependent anomalous K^+ influx means that K^+ influx at pH 3 is higher than that at pH 6 (ZSOLDOS and ERDEI, 1981). In Table 1 it can be seen that the anomalous K^+ influx can only be observed if 1/ rice seedlings were grown in 0.5

Table 1. $K^+(^{86}Rb^+)$ influx of roots of rice seedlings. Results are means ± S.D. of experiments of four independent cultivations.

State of roots	pH	Ca^{2+} (mM)	K^+ influx of roots (μmol x(g DW)$^{-1}$ x h^{-1}, grown in 0.5 mM $CaSO_4$	K^+ influx of roots (μmol x(g DW)$^{-1}$ x h^{-1}, grown in nutrient solution
Excised roots	3	–	86.8 ± 6.8	60.7 ± 6.0
	3	1	99.3 ± 5.9	71.5 ± 4.6
	3	10	112.0 ± 3.3	79.0 ± 9.3
	6	–	69.0 ± 6.2	70.4 ± 9.9
	6	1	93.0 ± 8.1	87.1 ± 8.1
	6	10	124.3 ± 5.3	106.7 ± 1.9
Intact roots	3	–	86.8 ± 8.7	70.5 ± 6.4
	3	1	97.8 ± 8.0	77.8 ± 5.5
	3	10	112.3 ± 4.5	92.7 ± 5.4
	6	–	87.2 ± 5.7	86.2 ± 6.6
	6	1	112.8 ± 9.5	104.8 ± 3.5
	6	10	153.0 ± 4.2	134.7 ± 4.8

mM $CaSO_4$ solution, 2/ the uptake experiments were carried out with excised roots, 3/ there was no Ca^{2+} present in the uptake solution. For comparison, the K^+ influx of wheat roots is presented in Table 2. It can be seen that neither excised nor intact roots showed the pH anomaly of K^+ influx. This latter result is in a good agreement with earlier data obtained with barley (FAWZY et al. 1954) or with perennial ryegrass (MURPHY, 1959). The VIETS-effect (VIETS, 1944) can be observed in all cases. The disappearance of the pH-dependent anomalous K^+ influx in rice with increasing Ca^{2+} concentration in the uptake solution verifies our earlier results (ZSOLDOS and ERDEI, 1981).

The K and Ca contents of the roots before the K^+ uptake experiments are summarized in Table 3. The data clearly show that K is only partly replaced by Ca; i.e. the cation equivalent constancy is not fulfilled here (BEAR and PRINCE, 1945; LUCAS and SCARSETH, 1947; BÉRCZI et al. 1984c). In the case of rice at pH 3, the K content of roots decreased, while Ca content did not change if Ca^{2+} was absent in the uptake solution at all four cases defined above.

In case of wheat at pH 3, however, not only the K content but also the Ca content of roots decreased during the K^+ influx experiments if Ca^{2+} was absent in the uptake solution (data not shown). This latter observation is consistent with earlier results; i.e. we know that 1/ the K^+ uptake of plants is regulated by a H^+-pumping ATPase (SZE, 1984), 2/ H/Ca exchange occurs in the cell wall under sudden acidic stress (SENTENAC and GRIGNON, 1981), and 3/ structural changes in the plasma membrane result in an increased leakage and possibly in K^+ loss (BÉRCZI et al. 1981). The first two statements are valid for rice too, but the third one is not

Table 2. K^+($^{86}Rb^+$) influx of roots of wheat seedlings. Results are means ± S.D. of experiments of four independent cultivations.

State of roots	pH	Ca^{2+} (mM)	K^+ influx of roots (μmol x(g DW)$^{-1}$ x h^{-1},grown in 0.5 mM $CaSO_4$	K^+ influx of roots (μmol x(g DW)$^{-1}$ x h^{-1},grown in nutrient solution
Excised roots	3	–	55.3 ± 6.1	22.1 ± 2.2
	3	1	68.2 ± 5.8	43.3 ± 4.1
	3	10	75.2 ± 6.6	68.6 ± 5.2
	6	–	73.6 ± 5.8	79.7 ± 6.9
	6	1	81.0 ± 6.2	89.4 ± 6.2
	6	10	111.6 ± 5.9	123.3 ± 5.3
Intact roots	3	–	52.3 ± 5.5	19.8 ± 3.1
	3	1	62.6 ± 6.1	37.7 ± 4.8
	3	10	74.8 ± 5.8	65.6 ± 6.3
	6	–	84.5 ± 6.8	73.6 ± 4.8
	6	1	97.4 ± 3.9	89.2 ± 5.3
	6	10	128.5 ± 4.7	121.3 ± 8.3

Table 3. Potassium and calcium content of rice and wheat roots before the K^+ uptake experiments. Data are means ± S.D. of experiments of four independent cultivations.

Plant	K and Ca content of roots (μmol x(g DW)$^{-1}$) grown in 0.5 mM $CaSO_4$		K and Ca content of roots (μmol x(g DW)$^{-1}$) grown in nutrient solution	
	(K)	(Ca)	(K)	(Ca)
Rice	383 ± 21	52.6 ± 1.6	648 ± 50	43.5 ± 1.8
Wheat	291 ± 24	41.3 ± 0.9	387 ± 7	38.7 ± 0.5

supported by ESR results (BÉRCZI et al. 1981). The lack of ions other than Ca^{2+} in the $CaSO_4$ growth solution, however, cannot alone be responsible for the pH dependent anomalous K^+ influx of excised rice roots, because the anomaly could not be observed with intact roots grown in the same solution. Our preliminary experiments with maize seedlings show similar results.

Thermophilic plants, which show not only the pH-dependent but also the temperature-dependent anomalous K^+ influx phenomenon (ZSOLDOS, 1968; ZSOLDOS and KARVALY, 1979), seem to be sensitive to excision. Taking into account both the

pH- and the temperature-dependent K^+ influx anomaly has been measured on excised roots, we think that the excision itself should be considered as a primary stress for the ion uptake of roots. Experiments and results obtained with „stress sensitive" plants and their explanation need close attention. In such cases, as our present paper suggests, results obtained with excised roots must not be automatically extrapolated to roots of intact plants.

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PROLINE-TYPE POLLENS AND THEIR VITALITY IN THE *ROSACEAE* AND THE SPECIES OF OTHER FAMILIES

S. GULYÁS and G. PÁLFI

(Received: June 30, 1985)

Abstract

In several plant species the free proline content of the vital pollens is between 1 and 2%. These are the proline-type pollens. The vitality percentage decreases to the same ratio as the ratio to which the proline content of the pollens is lower than 2.5%. The isatin reagent applied by us stains the pollen grains rather varying colours, depending on whether they possess sufficient proline content for the development of vitality, or not. Studies were performed on the pollens of 54 species belonging to 22 families of the *Angiospermae*. From these the pollens of 49 species were proline-typed, and the pollens of 5 species contained proline in an amount lower than 0.03%. The latter are the non-proline-type pollens. The 18 species of the Rosaceae family were all uniformly proline-typed. Our staining was positive in the case of 41 entomogame and 8 anemogame species, thus the mode of pollination does not influence the new determination of vitality. The isatin staining can only be applied in the case of proline-type species for the determination of the vitality of the pollens. This staining, however, needs to be studied separately for each species.

Key words: pollen, proline-isatin reaction, insect- and wind-pollination, angiospermal families.

Introduction

The water content of the pollen grains is quite low compared to other plant parts, according to species it varies between 20–40% of the fresh-matter (STANLEY and LINSKENS, 1974; BRITIKOV, 1975; ALARKON et al. 1978). At the same time, the water content of the mesophyte, the soft-stalked shoots and the leaves ranges from 80 to 95% of the fresh-matter. If the water amount in the leaves decreases to a level which is normal in the pollens, lethal water-insufficiency comes forth. It has been determined several times that in the case of the leaves of several soft-stalked plant species, the extremely high concentration of a specifically protein-amino-acid, the proline, is attained on the effect of the gradually developing water-deficit (ASPINALL et al. 1973; BATES et al. 1973; STEWART et al. 1977; TYMMS and GAFF, 1979; CHAUHAN et al. 1980; PÁLFI et al. 1983; 1984). Furthermore it has been proved that similarly to the leaves of plants suffering from water deficit, the proline concentration in the pollens of great number of plant species is also high (TUPY, 1963; DASHEK and HARWOOD, 1974; LINSKENS, 1974; DASHEK and MILLS, 1981; ZHANG and CROES, 1983). Considering their water and proline-contents, the pollens can therefore be regarded as cells showing water deficit. According to our opinion the degree of

vitality, germinative ability and fertility, resp., is directly proportional to the amount of accumulated proline in the species concentrating proline in their pollens. Several authors have published the physiological advantages of proline accumulation (ASPINALL et al. 1973; DASHEK and MILLS, 1981; TYANKOVA et al. 1982; ZHANG et al. 1982; ELTHON and STEWART, 1984). It has been determined that the high level of proline concentration increases the tolerance of water deficit in the plants and takes part in the protein synthesis following dehydration. According to ZHANG and CROES (1983) the proline accumulated in the pollens also promotes the protection against too high, or rather low temperatures.

KURSAKOV and RYZHKOV (1980) have determined that the proline functions in the development of the fertility of the pollens and its higher amount also significantly increases the rapidity of pollen germination as well as the elongation of the sac, respectively.

It has been demonstrated by TUPY (1963), LINSKENS (1974), MASCARENHAS (1975), AHOKAS (1978), DASHEK and MILLS (1981) and ZHANG and CROES (1983) that the proline of the pollen has important role also in the energetic transformations as well as in the interaction with the style. Besides, it is the effective activator of the Krebs-cycle and regulates the water balance and the normal functioning of certain enzymes as well. The authors have established that correlation can be found between the proline content of the pollens and the vitality as well as fertility, resp., in the case of numerous species of the flora.

PÁLFI et al. (1981), G. PÁLFI and ZS. PÁLFI (1982) have prepared amino acid extracts from the pollen masses of 18 kinds of inbred maize lines and have measured their proline content. According to their findings, the pollens belonging to that inbred line where the proline concentration is higher possess higher vitality. Even from the various rye species, the in vitro germinative percentage was higher for the species in which the proline concentration was also higher (PÁLFI and KÖVES, 1984). Authors determined that from the pollens of culture types belonging to the same species the vitality of those are of higher degree which species contain more proline. This fact has also been supported by the data of the in vitro germinations of the pollens on artificial, agar fostering soil, as well as of the proline concentrations in the amino acid extracts of the pollen masses.

Our new, rapid staining technique based on the proline content of the pollens has been described earlier, by which the approximate degree of vitality can be determined (ZS. PÁLFI and G. PÁLFI, 1982; PÁLFI and KÖVES, 1984). The isatin-reagent worked out experimentally by us stains the vital pollen grains dark blue or black. The non-staining pollens do not possess vitality. The aim of this paper was to study the vitality of the pollens of the *Rosaceae* family's most important fruit-bearing species on the basis of the proline content, using our isatin reagent. The proline concentration of the amino acid extracts prepared from the pollen masses was also determined. The isatinic vitality staining of a few wind-pollinated species was performed as well. Furthermore, it was also studied whether the vitality determination based on the proline content of the pollens can be adapted to every flowering plant species.

Materials and methods

The fruit-tree species belonging to the Rosaceae family and their certain cultivars, as well as the wind-pollinated species are listed in the Tables. The pollens in sacs were prepared in laboratory. The pollens were fixed and dried at 90 °C. The isatin staining indicating vitality can be performed with both living, or fixed pollens. The isatinic staining of the collected and dried pollens can be carried out either immediately or 1–2 years later.

The new composition of our isatin reagent is as follows: 0.6 ml of acidum aceticum is added to 20 ml of acetone in which 0.2 g of isatin is dissolved (stored in refrigerator it remains reactive for 3–4 weeks). Upon staining, 2–10 mg of pollen mass is placed on the slide and mixed well with 2 drops of isatin-reagent until the acetone evaporates. One-one drop of isatin is added twice more to the pollen mass, and the dissolvent is again evaporated by stirring. Then it is placed into the exsiccator heated up to 90 °C, where the stain is left to react for 12 minutes. Following this the preparation is taken out and left to cool. Then the slide is cleaned around the pollen mass with a slightly damp piece of cotton-wool. A drop of paraffine oil is dosed on the adhered pollens and the pollen grains are dispersed with a glass-stick. The pollens stained per grain to different colours are then covered by a glass cover and the colours are studied under microscope. Statistical evaluation is made of the yellow and light brown, as well as separately of the dark blue and black pollen grains, resp., so an approximate percental result can be obtained of the vitality degree. The colours of the preparations stained with isatin last differently according to species for 2–10 days, and even for 3 months in case of certain species (e.g. *Zea mays*).

The free proline content in the amino acid extracts prepared from the pollen masses (20–50 mg) was measured with the method of ASPINALL et al. (1973), as well as BATES et al. (1973).

Results and discussion

The vital pollen grains stain the following colours with isatin reagent, on the basis of the increasing order of their proline concentrations: greenish-blue, blue, dark blue, or black. The non-vital pollen grains keep their original yellow colour, or are stained light brown. In the black and white photographs, however, such colour deviations can not be seen — only the various shades of black and grey (Figs. of plate I. and II.). In the photos the black indicates the vital pollen grains and the shades of grey the non-vital ones.

The figures of Plate I. show the pollens of 6 species of the Rosaceae family following isatin staining. Owing to the insect circulation, however, there are also many pollens of foreign species. It can be determined that the majority of the pollen grains stained black, i.e. they are vital (PÁLFI and KÖVES, 1984). All studied species of the family are in general insect-, or self-pollinated. Regarding the figures of Plate I. the magnifications considerably differ from each other, nevertheless, the size and shape of the pollen grains of the various species are quite similar.

To clarify the proline accumulation and vitality degree, resp., of the pollens of the Rosaceae family, the pollens of a total of 18 species were collected. The obtained results can be seen on Table I.

According to the data of Table I. the amino acid extract of the total studied species of the *Rosaceae* family contains more than 1% proline. It is clear from the Table that the proline concentration in the pollen mass extracts varies in conformity with the percental result of the positive staining with isatin in the case of the various

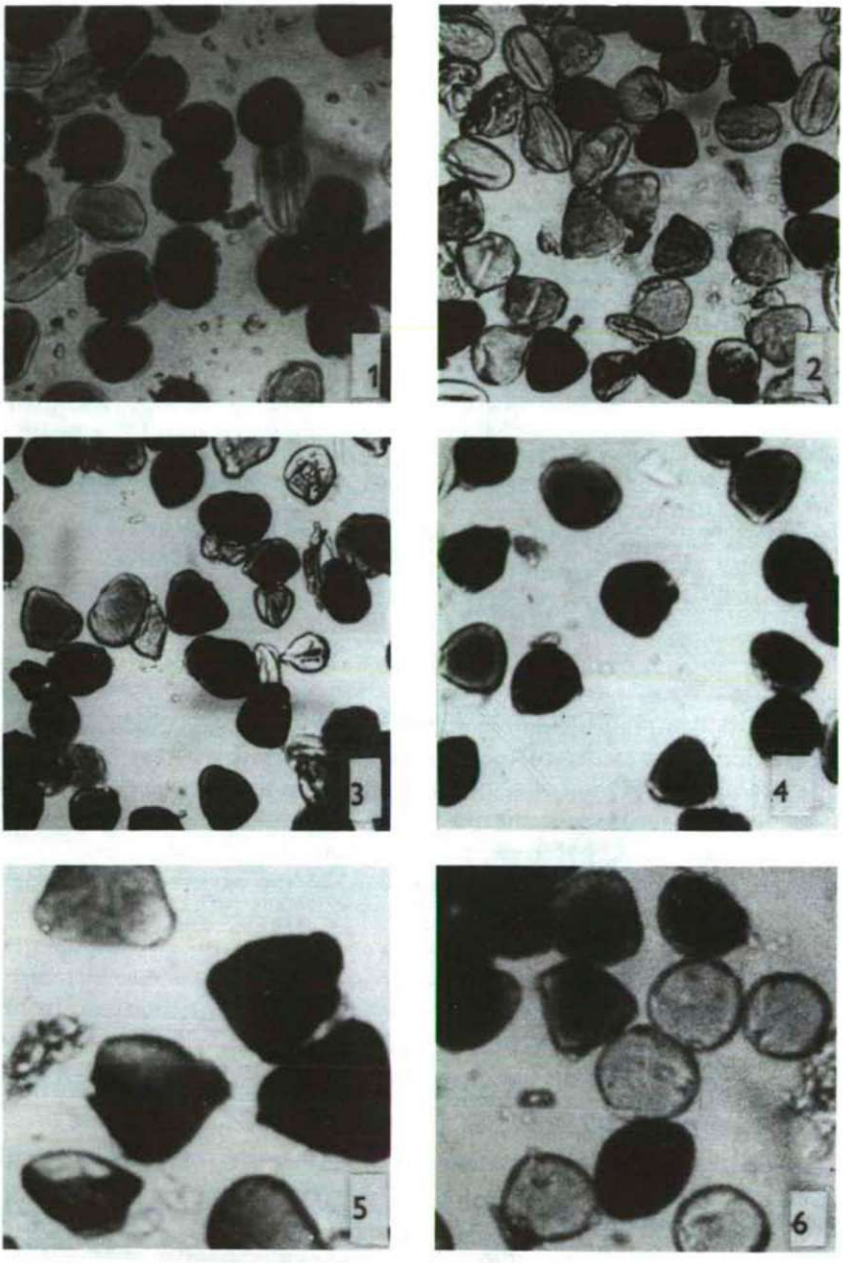

Plate I. The vital pollen grains stain black with isatin reagent. Insect-pollinated species — *Rosaceae* family. Magnification: 100-200 x

1 = *Rosa canina* L. ; 2 = *Pirus communis* L. cv. Keefer;
3 = *Malus pumila* L. cv. Jonathan; 4 = *Armeniaca vulgaris* LAM.
5 = *Persica vulgaris* MILL. cv. Madeline poujet; 6 = *Cerasus vulgaris* MILL. cv. Pándy.

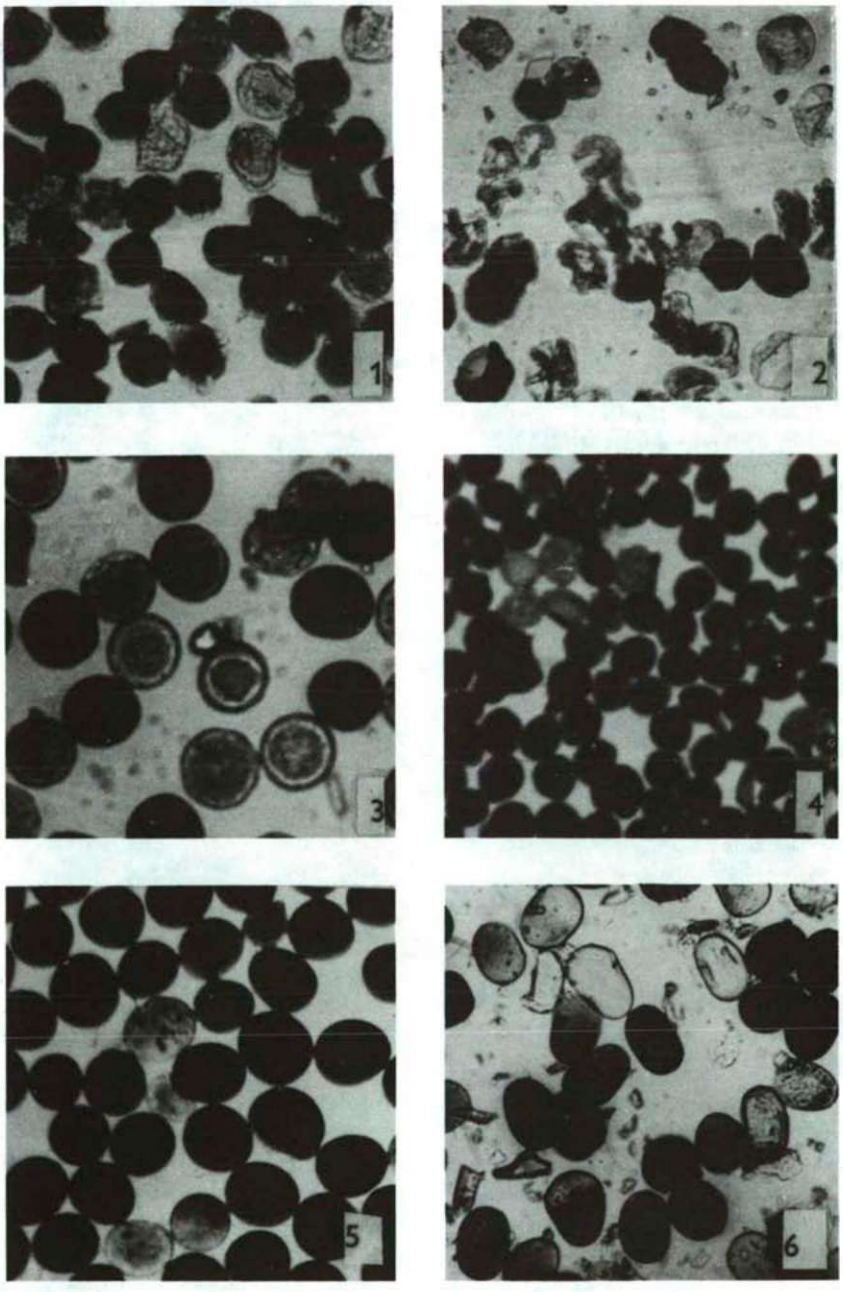

Plate II. Wind-pollinated species. The vital pollen grains are black. Magnification: 100 x

1 = *Fagaceae — Quercus robur* L.; 2 = *Salicaceae -Populus tremula* L.
3 = *Juglandaceae — Juglans regia* L.; 4 = *Betulaceae — Corylus avelana* L.
5 = *Gramineae — Zea mays* L.; 6 = *Secale cereale* L.

Table 1. Reaction to isatin staining of the pollens of 18 species belonging to the *Rosaceae* family. The pollen grains staining black and dark blue are isatin positive (vital). The proline concentration of the amino acid extracts prepared from the pollen masses is given in the percentage of the dry-matter.

Species	Proline concentration of extracts %	Positive staining with isatin (Vitality; %)
1. *Spiraea media* FR. SCHM.	1.84	81
2. *Exochorda korolkowii* LAVALL	1.66	73
3. *Cotoneaster horizontalis* DENCE	1.73	75
4. *Chaenomeles japonica* (THUNB) LINDL.	2.12	91
5. *Pyrus achras* GÄRTN.	1.18	46
6. *P. communis* cv. „Keefer"	1.26	50
7. *Malus pumila* cv. „Jonathan"	1.65	70
8. *M. floribunda* HOUTTE	1.47	57
9. *Crataegus oxyacantha* L.	1.63	72
10. *C. monogyna* JACQ.	1.61	70
11. *Pyracantha coccinea* ROEMER	1.36	53
12. *Rosa canina* L.	2.25	93
13. *R. polyantha* CARR cv. „Golden showers"	1.08	44
14. *Cerasus vulgaris* MILL. cv. „Pándy"	1.38	56
15. *Cerasus avium* MÖNCH. cv. „Germersdorfi"	1.46	58
16. *Armeniaca vulgaris* LAM. cv. „Mammut"	1.77	76
17. *Persica vulgaris* MILL. cv. „Madeline poujet"	1.45	53
18. *Prunus domestica* L. cv. „Olaszkék"	1.82	79

(Average deviation being below ± 5 per cent; n = 4 and 5)

species, as it has already been determined by others as well as ourselves (TUPY, 1963; STANLEY and LINSKENS, 1974; BRITIKOV, 1975; G. PÁLFI and ZS. PÁLFI, 1982; PÁLFI and KÖVES, 1984).

It was further studied to what extent this extremely great proline accumulation of the pollens has spreaded among the angiospermal, flowering plants. To partially answer this question the proline content and isatin staining of the pollens of further 23 species belonging to 16 families were investigated (Table 2).

It can be established from Table 2. that the proline concentration of all 23 species is between 1 and 2% (counted for dry matter). It can also be observed that the positive isatinic staining, i.e. the vitality percentage also changes in accordance with the proline concentrations of the amino acid extracts prepared from the pollen masses.

Table 2. Isatin positive staining (vitality %) of the pollens of 23 insect-pollinated species belonging to 16 families. Proline percentage(dry-matter).

Families	Species	Concentration of the proline; %	Positive staining (Vitality; %)
Paeoniaceae	1. *Paeonia officinalis* L.	1.43	56
Ranunculaceae	2. *Ranunculus acris* L.	1.75	76
Grossulariaceae	3. *Ribes rubrum* L.	1.18	45
	4. *R. aureum* PURSH.	1.26	51
Caesalpiniaceae	5. *Cercis siliquastrum* L.	1.55	60
Papilionaceae	6. *Caragana sophorae* LAM.	1.26	49
Hippocastanaceae	7. *Aesculus hippocastanum* L.	1.88	82
Caprifoliaceae	8. *Viburnum lantana* L.	1.34	53
	9. *Lonicera tatarica* L.	1.53	61
Malvaceae	10. *Lavatera thuringiaca* L.	1.42	56
	11. *Abutilon theophrasti* MEDIK	1.69	74
Euphorbiaceae	12. *Euphorbia cyparissias* L.	1.81	80
Labiatae	13. *Lamium purpureum* L.	1.06	43
Papaveraceae	14. *Chelidonium majus* L.	2.17	92
Cruciferae	15. *Lepidium draba* L.	1.24	46
	16. *Arabis procurrens* L.	1.63	71
Compositae	17. *Bellis perennis* L.	1.50	60
	18. *Senecio vernalis* W. et K.	1.68	73
Cactaceae	19. *Opuntia vulgaris* MILL.	2.06	88
	20. *Cereus peruvianus* L.	1.73	75
Primulaceae	21. *Primula veris* HUDS.	2.15	90
	22. *P. acaulis* L.	2.18	90
Iridaceae	23. *Iris germanica* L.	1.37	54

(Average deviation being below ± 5 per cent; n = 4 and 5)

The pollens of the 41 species belonging to the 17 families published so far are in general insect-pollinated ones. Now 6 figures of isatin staining are demonstrated prepared of the pollens of mainly wind-pollinated species (Figs. of Plate II).

The figures of Plate II. give evidence that the proline accumulation of the pollen grains (black grains) also has prevalence in the case of the wind-pollinated plants. It follows from this that the demonstration of the vitality of the pollen grains with the rapid isatinic technique can also be applied for the wind-pollinated species. Naturally, further study and results of several species are required for final decision.

The proline concentrations and positive isatin staining of the extracts prepared from the pollen masses were determined in the case of 8 wind-pollinated species belonging to 5 families (Table 3).

Table 3. shows that all proline concentrations in the studied 8 kinds of wind-pollinated species are between 1 and 2.5%, similarly to those of the insect-pollinated species. In accordance with the changes in the proline concentrat-

Table 3. Isatin positive staining and proline concentration of the pollens of wind-pollinated species. The 8 species belong to 5 families.

Families	Species	Concentration of the proline; %	Positive staining (Vitality; %)
Betulaceae	1. *Corylus avelana* L.	2.28	92
	2. *Betula pendula* ROTH	1.33	50
	3. *Alnus glutinosa* L.	1.27	46
Fagaceae	4. *Quercus robur* L.	1.81	80
Juglandaceae	5. *Juglans regia* L.	1.52	59
Salicaceae	6. *Populus tremula* L.	1.45	56
Gramineae	7. *Secale cereale* L. (cv.Lovászpatonai)	1.36	52
	8. *Zea mays* L. (Inbred linie V216)	2.34	94

(Average deviation being below ± 5 per cent; n = 4 and 5)

ions, the percental result of the positive isatin staining changes here, too. Thus, during the course of our experiments carried out so far, the isatinic rapid staining technique processed by us, indicating the vitality of the pollen grains, can also be applied in the case of the wind-pollinated species. The proline concentration of the vital pollens was above 1% here, too, therefore, according to our naming the pollens of these species are also „proline-typed". 5 species have been found among the pollens of the 54 species studied so far, which do not possess proline-typed pollens. Accordingly, not every pollen of the angiospermal species of the flowering plants is proline-typed (Table 4).

Table 4. Vital pollens of species in which the proline concentration of the amino acid extracts does not reach 1.0% of the dry-matter; non „proline-type pollens". The 5 kinds of insect-pollinated species belonging to 3 families produce non-proline-type pollens. The proline concentration of these is below 0.03%, therefore they do not stain wih isatin reagent.

Families	Species	Concentration of the proline; %	Positive staining (Vitality; %)
Begoniaceae	1. *Begonia semperflorens* LK. et OTTO	0.026	–
Cucurbitaceae	2. *Cucurbita pepo* L.	0.022	–
	3. *Cucurbita maxima* DUCH	0.025	–
	4. *Cucurbita moschata* DUCH	0.018	–
Compositae	5. *Helianthus annuus* L.	0.021	–

Table 4. comprises 5 such insect-pollinated species that have proline concentrations not reaching 1%, moreover, being below 0.03%. These are the real, „non-proline-type species". In the case of such low proline content, naturally the positive isatin staining of the pollen grains cannot be attained (although, as studied by us, the pollens possess a significant degree of vitality). It can be seen that in regard to the pollen, the non-proline-type species constitute only approximately 10% of the total species studied by us so far. Therefore, there are essentially more proline-type species in nature.

It has already been established by numerous authors (TUPY, 1963; CHUVASHINA and MELYNIKOV, 1964; STANLEY and LINSKENS, 1974; MASCARENHAS, 1975; AHOKAS, 1978) that the proline concentration of the most highly vital pollens falls to 2.5% of the dry matter (if the species is proline typed).

It can unambiguously be determined from Tables 1–3. that the percental ratio of the positively stained pollens decreases to the same degree as the proline concentration is less than 2.5%. Namely, in the case of plant species or types where the total pollen grains are vital, the proline concentration reaches the value of 2.5%.

Considering that the protein and free amino acid composition of the pollens of the different species varies, the isatinic staining of the vital pollen grains may appear by the different shades of the dark colours. Accordingly, for the purpose of determining the degree of vitality, the isatinic staining of every species should be studied separately.

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THE EFFECT OF VARIOUS NUTRIENT SUPPLIES ON THE LEAF MORPHOLOGY AND ANATOMY OF THE *DIGITALIS LANATA*

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Abstract

The effect of the various doses of three basic nutrient elements (nitrogen, phosphorus, potassium) on the morphological and anatomical features of the *Digitalis lanata* rosette was studied under controlled condition. It could be determined that the leaf-number and-area change to a variable extent depending on the nutrient type, but in all cases following an optimum curve. On the contrary, the connection between the leaf thickness and the nutrient element levels could be regarded to be close to linear. Consequently the decrease of the leaf-number and-area experienced in the case of high doses is accompanied by the further increase of the leaf thickness.

The determination coefficients indicate that from the basic processes producing the morphological and anatomical changes, the differentiation and cell division — being elemental in the development of the leaf-number and-area — are affected by the phosphorus doses besides that of nitrogen. The cell enlargement, which is fundamental from the viewpoint of the leaf thickness, is modified mainly by the potassium amount.

Key words: *Digitalis lanata*, leaf morphology, leaf anatomy, nutrients.

Introduction

The response-reactions of plants to environmental effects are also expressed in the changes of their growth processes, which results in modification in the size, shape and mass ratio of the organs as well (WATSON and CASPER, 1984). From the viewpoint of morphology and anatomy, the most changable organ is the leaf (FAHN, 1982) which -in respect to the significance of photosynthesis- has firstly been studied with light, as an ecological factor. As general effect, among others the development of larger surfaced, thinner leaves (BJÖRKMAN, 1981) as well as the appearance of undeveloped palisade parenchyma (JACKSON, 1967) and large size intercellulars (FEKETE et al. 1973) are characteristic of the weak light.

At the same time, intensive illumination accelerates the formation of the palisade parenchyma and causes a decrease in the leaf area (SHIELDS, 1950). In many cases this is accompanied by the decrease in size of mesophyll cells too, resulting the increase of the internal surface (NOBEL, 1977). Among the effects of nutrients — first of all nitrogen phosphorus and potassium- the most well known are those of morphological nature, which have been described in detail in the work of BERGMAN

(1979). It is striking that there is relatively few data in respect to the anatomical changes concerning nutrient supply, which has comprehensively been studied both from physiological and production-biological points of view. Accordingly the characteristic of nitrogen-shortage is the inhibition in growth of the shoot, the formation of chlorotic and xeromorph leaves. In case of phosphorus shortage the symptoms are similar, but of slighter degree. In case of potassium shortage the small sized leaves also show characteristic „wilting" symptoms, caused by the shrinkage of the mesophyll cells. At high nitrogen level, besides the intensive growth, there is an increase in the ratio of the parenchyma cells contrary to the supporting elements, which makes the leaves „loose and soft".

In the case when the leaf signifies the utilizable organ, the modification of the leaf structure by the effect of nutrients is of particular importance. The heart-glycosides used as a basic material for medicaments occur in highest amounts in the leaf parenchyma of the *Digitalis lanata* (VOGEL and LUCKNER, 1981), thus the leaf size and mesophyll structure modified by nutrient supply may play important role in the development of the drug production and glycosid quantity. In connection with the above mentioned factors, but mainly in respect to production, a lot of contradictory data are known, which are summarized by BAALBA et al. (1971). Both stimulation, and inhibition of growth on the effect of nutrients are discussed in the cited paper, which can presumably be led back to the interaction of several climatic factors, or to the different nutrient element ratio.

In the present paper attempt is made to clarify the effect of three basic nutrient elements (nitrogen phosphorus, potassium) and their various doses on the leaf-number and-area, as well as anatomy of the *Digitalis lanata*, under conditioned condition. With this, authors wish to improve the knowledge on the morphological-anatomical background of the increase in glycoside production.

Material and method

The studies were performed in PGB-36(Conviron) type phytotron chamber using *Digitalis lanata* EHRH cv. „Oxfordi" plants. During the growth period the strenght of the illumination was 16 klx, and the phase 14 hours. The light energy was served by light tubes in 86% (F72 T12 (CW/Who) and by incandescent lamps in 14%. The relative humidity in the light/dark periods was 60/70%. In accordance with the values characteristic to the certain sections of the average 169 days long natural vegetation period, the temperature was as follows:

period	day(°C)	night(°C)
1– 2 weeks	16	10
3– 7 "	18	12
8–11 "	20	12
12– "	21	12

1-1 plant was grown in the culture dishes of 154 cm^2 area and 1300 cm^3 volume, in the equal massproportioned mixture of sand-perlite, using modified KNOP nutrient solution. The nitrogen, phosphorus and potassium contents of the nutrient solution differed in each variant (Table 1.). The effect of the quantitative changes in the various nutrient elements was examined besides the median dose and

Table 1: Nutrient solutions dosed per plant in 10 day-period

Nutrient level	N dose(mg)	P dose(mg)	K dose(mg)
$N_1P_3K_3$	5.0	50.0	50.0
$N_2P_3K_3$	25.0	50.0	50.0
$N_3P_3K_3$	100.0	50.0	50.0
$N_4P_3K_3$	200.0	50.0	50.0
$N_5P_3K_3$	400.0	50.0	50.0
$N_3P_1K_3$	100.0	2.5	50.0
$N_3P_2K_3$	100.0	12.5	50.0
$N_3P_4K_3$	100.0	100.0	50.0
$N_3P_5K_3$	100.0	200.0	50.0
$N_3P_3K_1$	100.0	50.0	2.5
$N_3P_3K_2$	100.0	50.0	2.5
$N_3P_3K_4$	100.0	50.0	100.0
$N_3P_3K_5$	100.0	50.0	200.0

The nutrients were applied in the form of NH_4NO_3, NaH_2PO_4 and KCl

unchanged ratio respectively, of the other two. 9-9 plants were evaluated per variant, processed on the 169th day following sowing in conformity with the average lenght of the natural vegetation period. During the course of the evaluation the leaf number, and leaf area were determinated. 50-50 measurements per variant were accomplished for the analysis of the mesophyllum structure. The sections were prepared according to the description given in our previous paper (MIHALIK and BERNÁTH, 1984). The determination coefficient were defined by the method of SVÁB (1973).

Results and discussion

1. RELATIONSHIP BETWEEN THE LEAF NUMBER PER PLANT AND THE NUTRIENT SUPPLY

The leaf number (Table 2.) is influenced to greatest extent by the nitrogen from the studied nutrient elements. With nitrogen insufficiency (N_1 variant) there is a considerable slackening in growth and fewer are formed by more than 60% compared to the formations at medium nutrient level (N_3). Higher nitrogen doses also result a significant decrease in the leaf number, moreover, even symptoms of intoxication can be detected in the case of the N_5 variant: The initial fast growth is followed by chlorosis, then by destruction of the leaves. Even if phosphorus amount is increased, the optimum of the leaf number is experienced at the medium level (P_3). The shortage of phosphorus is only of slight degree, while the excess brings forth a considerable decrease, however preceivable toxic symptoms do not appear in this case. Among the studied nutrients the effects of potassium is the slightest, disregarding extreme potassium insufficiency the leaf number is practically constant.

Table 2.: Leaf number and leaf area per plant

Nutrient level	leaf no.	leaf area(cm^2)
$N_1P_3K_3$	53.3	3400
$N_2P_3K_3$	97.5	4812
$N_3P_3K_3$	124.7	7821
$N_4P_3K_3$	99.6	4756
$N_3P_1K_3$	113.1	5343
$N_3P_2K_3$	124.2	5887
$N_3P_4K_3$	116.8	5322
$N_3P_5K_3$	79.1	3527
$N_3P_3K_1$	101.2	5689
$N_3P_3K_2$	128.2	5656
$N_3P_3K_4$	121.0	6110
$N_3P_3K_5$	125.3	5590

2. CHANGES IN LEAF AREA

The leaf area is formed along a curve optimal with the quantitative increase of all three nutrient elements. The maximum of the curve is observable at the $N_3P_3K_3$ level. As the result of the growth inhibition caused by the nitrogen insufficiency and phosphorus redundancy, the leaf area is the smallest in the case of N_1 and P_5 doses. The potassium has no basic importance here either, since the difference between the variants is relatively slight.

3. THE THICKNESS AND STRUCTURE OF THE LEAF

In contrast to the characteristics studied hitherto, the leaf thickness shows a close to linear increase with the rise of the nutrient level (Table 3). The linearity is the best evident in the case of nitrogen, it shows a transition towards the asymptotic curve in the case of phosphorus, while it only prevails with tendency character upon the increase of the potassium level. At low nitrogen and phosphorus levels it is not only less and of smaller size, but thinner leaves are formed as well. The effect of the potassium insufficiency is not unambiguous, however, its redundancy among the studied nutrients levels results in the formation of the thickest leaves. The leaf thickness firstly depends on the lenght of the palisade cells, and to lesser extent on the number of cell rows (Table 3.), the thickness of the spongy parenchyma is practically constant under our experimental conditions. In the case of nitrogen and phosphorus insufficiency the columnar parenchyma cells are cuboid, the „palisade character" is not expressed (Plate 1, fig. 1.). This phenomenon cannot be experienced in the case of potassium insufficiency. On the effect of high doses the thickness of

Table 3: Anatomic characteristic

Nutrient level	leaf thickness (μm)	palisade parenchyma thickness (μm)	palisade parenchyma cell rows no.
$N_1P_3K_3$	247.8	79.2	2.5
$N_2P_3K_3$	260.4	93.9	2.0
$N_3P_3K_3$	296.8	99.9	2.4
$N_4P_3K_3$	339.8	125.2	2.7
$N_3P_1K_3$	232.1	78.6	2.0
$N_3P_2K_3$	299.0	111.8	2.8
$N_3P_4K_3$	313.7	120.7	2.8
$N_3P_5K_3$	314.5	121.8	2.7
$N_3P_3K_1$	317.0	124.9	2.8
$N_3P_3K_2$	299.8	113.5	2.8
$N_3P_3K_4$	364.8	141.1	2.9
$N_3P_3K_5$	348.9	160.8	3.0

the palisade layer suprasses the value of the moderate nutrient element level by 20-50%, and the increase is the highest in the case of the K_4 variant (Plate 1. fig. 3.).

Apart from the mesophyll structure, the quality of the cell walls is also changed by the nutrient supply. In the case of nitrogen insufficiency the cell walls are thin and only weakly stainable; on the effect of phosphorus redundancy they become stiff and fragile, thus the leaves can only be cut with difficulty.

4. CHARACTERIZATION OF THE EFFECTIVENESS OF THE NUTRIENT ELEMENTS

The determination coefficient may provide us with information regarding the degree to which the nutrients and their combinations contribute at the development of the various changes (Table 4.). The role of the nutrient eleme is relatively moderate in the development of the leaf number. The effects of potassium seems to be negligible,

Table 4: Percentage values of determination coefficient

Nutrient elements	leaf number	leaf area	leaf thickness	palisade parenchyma thickness
N	19	33	32	23
P	15	29	8	5
K	4	14	18	35
N+P+K	38	76	58	63

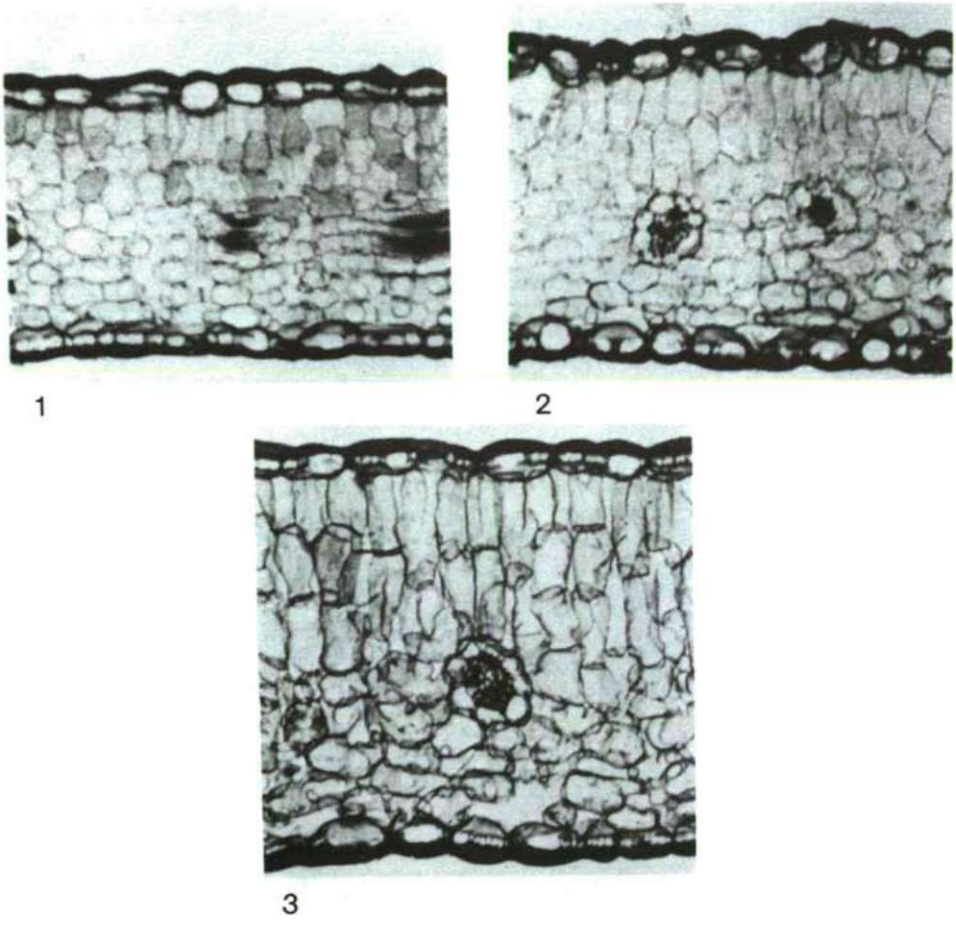

Plate 1. Tissue structure of the leaf mesophyll of *Digitalis lanata*: 1 = low nutrient level, 2 = medium nutrient supply, 3 = general effect of nutrient redundancy

only nitrogen and phosphorus influence the leaf formation slightly. The leaf area however depends to a greater extent on the nutrient element amount (76%). Similarly to the leaf number, apart from the nitrogen, the significance of phosphorus can be emphasized here, too, though an increase in the influence of potassium can be observed.

The leaf thickness as well as the thickness of the palisade layer determining this, respectively, also depend on the nutrient supply at the applied light intensity. It should be emphasized that contrary to previous two features, besides the nitrogen, the role of potassium becomes greater. This is particularly striking in the case of the palisade parenchyma thickness, where the determination coefficient of potassium is 35%.

According to our assumptions the influence of the nutrient elements goes through two different directions. In the development of the leaves and growth of the leaf area where the cell division dominates, the effects of nitrogen and phosphorus could be demonstrated successfully. In the cell enlargement, which is the main factor the growth in leaf thickness, the role of potassium is more significant.

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RELATIONSHIP BETWEEN NON-STRUCTURAL CARBOHYDRATE CONTENT OF THE LEAF AND GROWTH IN MAIZES GROWN IN SHORT AND LONG LIGHT–DARK PERIODS

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Abstract

The dry mass accumulation as well as soluble sugar and starch content of the leaf lamella of P165 and F2 inbred maize lines were studied in 16–8 hours, 30–15 mins and 15–7.5 mins light–dark periods (LDPs), on the 16th, 32nd and 48th days counted from sowing.

It was determined that the growth rate of the two maize lines also differed in the 16–8 hours LPD: first the dry mass of the P165 was greater, then that of the F2 line.

The starch content of the 2. leaf lamella in the second week following its complete development increased in the case of the P165 maize, that of the 4. leaf decreased; it barely changed in the case of the F2 maize in 16–8 hours LDP.

The short LDPs generally decreased the dry matter and leaf carbohydrate content, but the 30–15 min. LDP — even in case of the more sensitive P165 — produced an opposite effect sometimes: the dry mass of leaf of the 16 day old plants (and the 32 day old F2) as well as the starch content of the developed 2. leaf increased. The decrease of total non-structural carbohydrate content of the leaf firstly inhibited the growth of the root.

The relative starch content was higher in the basal part of the leaf blade than that of in the apex.

Key words: maize line, light–dark period, dry mass, soluble sugar and starch content

Introduction

The growth of a plant greatly depends on its total non-structural carbohydrate (TNC) content, distribution as well as the intensity of its transport and metabolism. GENT (1984) found tight positive correlation between the TNC content and relative growth ratio of young tomato plants. Relationship was found between the growth per organ of the biomass and the carbohydrate distribution pattern (SCHULZE et al. 1983). There is a negative connection between the starch content of the leaf and the relative mass of the root (HUBER, 1983).

The TNC content of the leaf and within this the ratio of the starch and sugars are influenced by external and internal factors, e.g. the genotype (HUBER, 1983; AVIGAD, 1982). During the increase of the assimilation rate the starch synthesis shows a more abrupt rise than that of the sucrose thus their ratio changes in the leaf of bean plants (SHARKEY et al. 1985).

In young maize the fixed carbon incorporates into reductive sugars in the lower leaves, and into sucrose in the upper ones (MOROT–GAUDRY et al. 1979).

The level of transport sugar increases during the expansion of the leaf (PHARR and SAX, 1984). The starch content in the developed source leaf inversely depends on the ratio of sink and source parts of the plant (MAYORAL, 1985). There is a difference between the utilization and transport, resp., of the sugars and starch during the dark period: in the lower leaves there is a greater decrease in the starch content, while in the upper leaves the greater decrease is found in the sugar content (CHANG, 1980). From the effects of the environment the shortening of the light period causes an increase in the starch content of the leaf (CHATTERTON and SILVIUS, 1979).

The earlier studies performed in alternating light–dark periods (LDPs) demonstrated that if the plant receives the daily light amount in short periods alternated with dark, this generally has an unfavourable effect (SAGER and GIGER, 1980). The dry mass and carbohydrate content (MARÓTI and MIHALIK, 1984; MARÓTI and MARGÓCZI, 1984); the amount of pigments in the leaf (MARÓTI, 1982); the grana area ratio in the chloroplasts (TAKÁCS and MARÓTI, 1984) decrease. These changes are firstly determined by the lenght of the light period, but also depend on the genotype (MARÓTI et al. 1981), and the above mentioned publications occasionally describe positive effects as well. There are no data available in regard to the behaviour of various aged plants and leaves, resp., during short LDP.

The present paper studies two maize lines of dissimilar behaviour in two short LDPs, which often differ in their effects. Analysis is given of the distribution of the dry mass at 3 ages, as well as of the soluble sugar and starch contents of the 2. and 4. leaves in their fully developed and older state. Our aim was to search for correlations between the carbohydrate content of the leaf and the growth, furthermore, to analyse and interpret the differing behaviour of the maize lines.

Materials and methods

P165 and F2 inbred maize lines were used in our experiments. The maize grains were sown in the mixture of sand and perlite in a ratio of 1:1. 3–3 plants were placed in each 600 cm^3 sized plastic pot. The humidity and nutrient content of the medium was ensured by modified HOAGLAND nutrient solution (see composition MARGÓCZI and MARÓTI, 1985). The moisture content of the medium (80% of the whole water capacity) was maintained daily by watering with destilled water. The plants received 20 ml of nutrient solution twice a week per pot.

The temperature in the phytotron climate chambers was 21 ± 2 °C, ensuring 185 $\mu molm^{-2}s^{-1}$ light intensity during the light periods with F33 type light tubes.

Three kinds of light treatments were applied: in the first chamber 16 hours light and 8 hours dark (16–8 hours LDP), in the second 30 min. light and 15 min. dark (30–15 min. LDP), and in the third 15 min. light and 7.5 min. dark (15–7.5 min. LDP) alternated. The plants were analysed at the age of 16, 32 and 48 days. 4–4 repetitions were formed from the 12–12 plant per treatment.The 2. leaves of the 16 day old plants, on which the lingules had just appeared (this indicating the complete development), were immediately fixed with heat following cutting (105 °C, 5 min.) and dried at 60 °C. The soluble sugar and starch contents were measured separately in the basal and apex part of the dried leaf blades (without the midrib). The just developed 4. and 2. leaves of the 32 day old plants, as well as the older 4. leaves of the 48 day old plants were analysed in similar manner. The dry mass of the other parts of the plants was measured per organ, after drying at 60 °C.

The carbohydrate content was determined according to the earlier description (MARÓTI and MARGÓCZI, 1984): the sugars were extracted with hot water, the starch from the remaining substance with perchloric acid. The carbohydrate content in the extracts was measured by the colorimetric method of DUBOIS et al. (1956). Soluble sugar + starch = total non-structural carbohydrate (TNC). The obtained results were evaluated by two-factored variancy-analysis (SVÁB, 1981).

Results

1. DISTRIBUTION OF DRY MASS PER LEAF STAGE AND DRY MASS RATIO OF THE ROOT

The dry mass of the 1., 2. and 3. leaf blade was less in the case of the F2 line compared to that of the P165 maize, and its increase was also slighter. The mass of the 4. leaf was close to similar in both lines, but the 5. and 6. leaves had greater mass in the F2 line and also grew faster in the 16–8 hours LDP (Fig. 1).

The 30–15 min. LDP exerted positive (or indifferent) effect on the accumulation of dry mass of the leaf in every leaf stage at 16 day old age, and the 15–7.5 min. LDP did not cause significant decrease either, compared to the 16–8 hours LDP. At the age of 32 days a considerable decrease was observed in the dry mass of the 4. leaf, having most of all source nature. This was also the case concerning the 5. leaf of the P165 line. However, the 5. leaf of the F2 had significantly greater mass in the short LDP, compared to the 16–8 hours LDP (Fig. 1b). Even at the age of 48 days the dry mass of the largest, chiefly source-character leaves showed the greatest decrease in the short LDPs (Fig. 1c). Between the age of 16 and 48 days there was a decrease in the root dry mass ratio of the plants (root dry mass/total dry mass) (Fig. 1). In the case of the F2 line this decrease was greater than in that of the P165.

The short LDPs — especially the 30–15 min. LDP — reduced the dry mass ratio of the root.

2. CARBOHYDRATE CONTENT IN THE 2. AND 4. LEAF BLADES

In the 16–8 hours LDP the leaves of P165 and F2 lines accumulate the carbohydrates differently: significantly higher amount of starch was found in the 2., older leaf of the P165 line compared to the developed leaf (Fig. 2a), while this was not so in the case of the F2 maize leaf (Fig. 2b). The carbohydrate transport from the 2. leaf of the F2 line was probably more intensive. On the contrary, the starch level slightly decreased (but significantly) in the older 4. leaf of the P165 maize compared to the developed leaf, but that in the 4. leaf of the F2 line did not (Fig. 2b); i.e. here the transport was possibly more intensive from the 4. leaf of the P165 line.

The soluble sugar and starch content in the 2. and 4. leaf blade of the P165 line showed extrem reaction to the short LDP treatment (Fig. 2a). The sugar content decreased considerably and significantly in every case compared to the 16–8 hours LDP, similarly decreased the starch content in the older 2. and developed 4. leaves of the 32 days old plants.

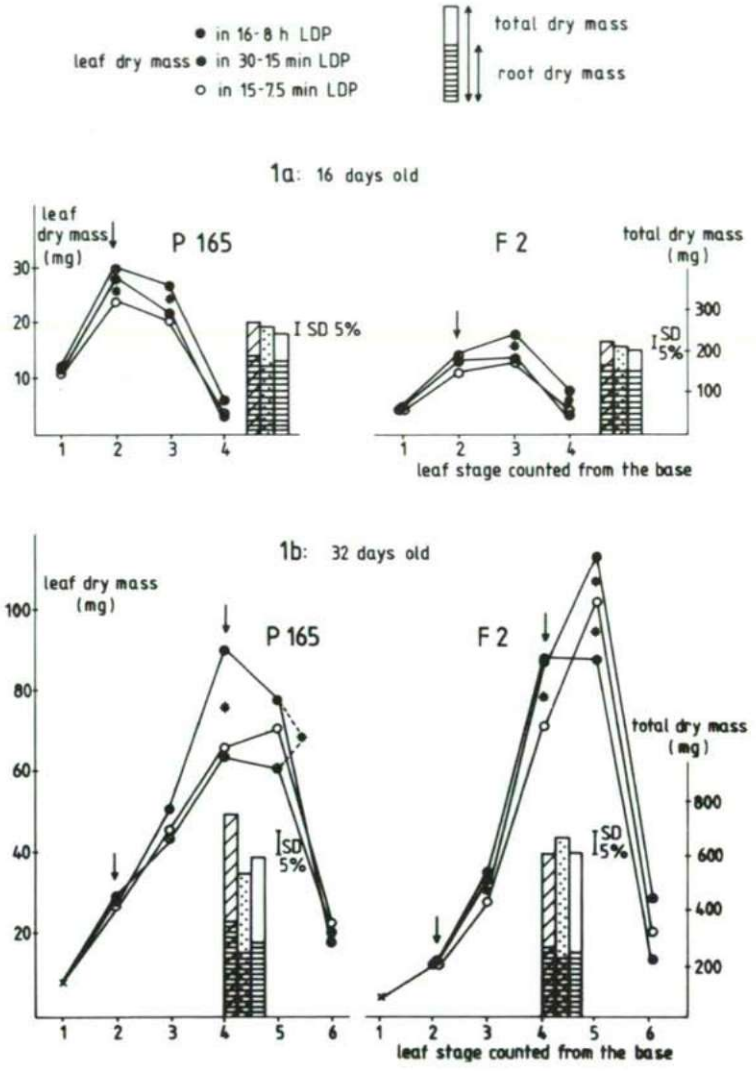

Fig. 1. a—b

The starch content of the just developed 2. leaf was strikingly high in the 30–15 min. LDP compared to the 16–8 hours LDP (Fig. 2a). This was presumably due to the fact that this LDP enhances the carbohydrate transport of the seed (and perhaps even that of the leaves), this is why the leaves become bigger here at the age of 16 days. This has been assumed in the case of other maize genotypes, too (MARGÓCZI, 1984).

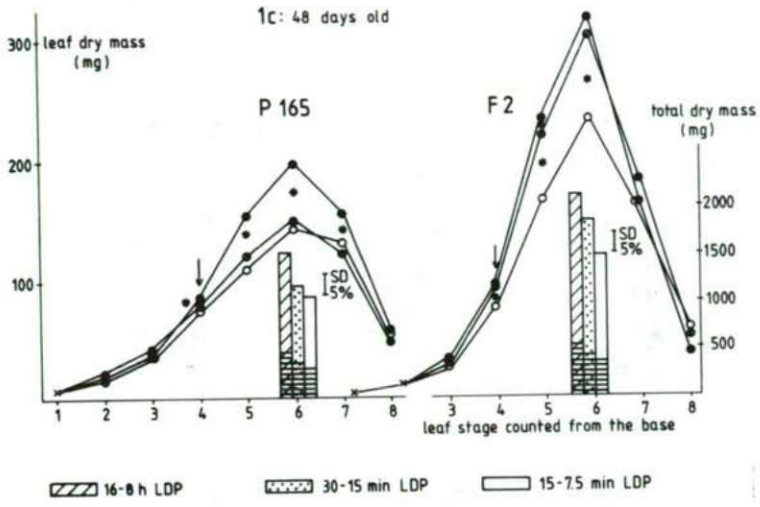

Fig. 1. Effect of short LDP treatment on the dry mass of the leaves per leaf stage; on the dry mass of the whole plant, and within this on the root share in the case of a: 16, b: 32, c: 48 day old plants.
*: Significant difference at the level of P = 0.05. Carbohydrate content determination from the leaves labelled by arrows.
$SD_{5\%}$: Significant difference at the level of P = 0.05 between the values per treatment of the total dry mass.

In the case of the F2 genotype an elevated starch level in the 2. leaf could hardly be observed on the effect of 30–15 min. LDP (Fig. 2b). This line was at a disadvantage at the age of 16 days in comparison with the P165 line (Fig. 1a), i.e. the reserved utilization of the seed was less intensive and was only slightly increasing on the effect of 30-15 min. LDP.

The carbohydrate content in the studied leaves of the F2 line only occasionally showed significant decrease on the effect of both short LDP treatments (e.g. the sugar content of the 4. leaf, Fig. 2b). The starch level of the leaf blade was only decreased in places significantly by the 15-7.5 min. LDP. It has also been found to be generally valid in the case of other maizes that the short LDP produces a greater decrease in the soluble sugar, than in the starch level of the leaf (MARGÓCZI, 1984).

3. TNC CONTENT OF THE LEAF AND RELATIVE GROWTH

The relative growth of the root and the young leaves was compared in the given time period with the TNC content of a leaf stage which had stopped growing, thus being of source nature and exporting photosynthates (Fig. 3).

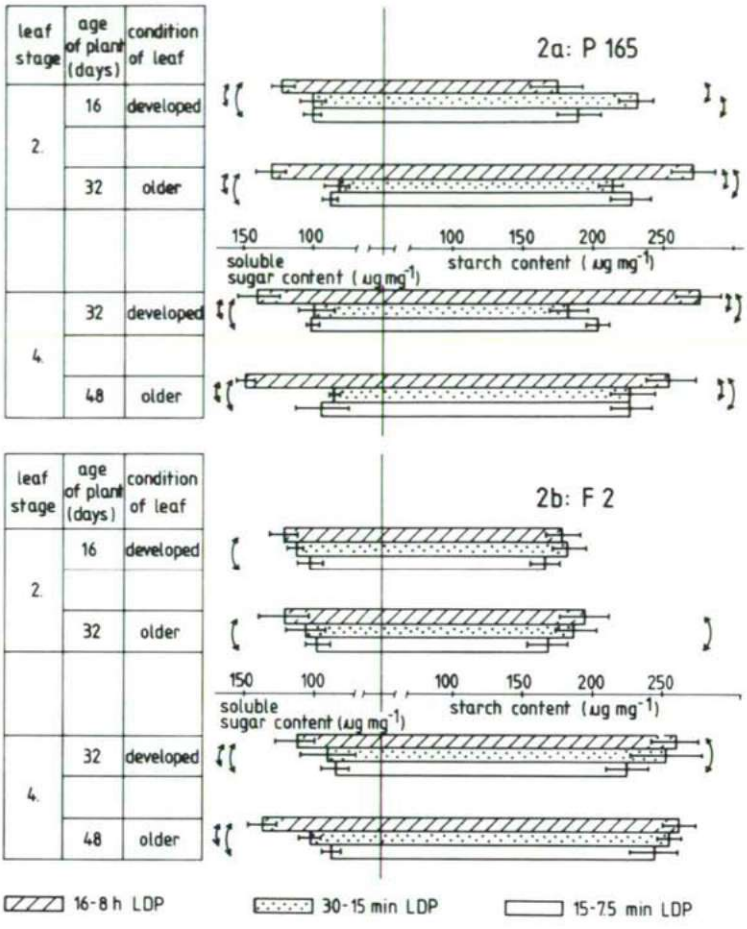

Fig. 2. Soluble sugar and starch content in the blades of the 2. and 4. leaves related to dry mass unit, in the case of leaves of two different stages of development in long and two short LDPs. a : P165 line, b: F2 line.
(The data are averages of measurements made separately from the basal and apex parts of the leaf lamella). The difference between the data pairs indicated by arrows is significant at the level of $P = 0.05$.

It was determined that the lower TNC content of the studied leaf was generally accompanied by slighter relative root growth in the short LDPs, however, the relative growth of the leaves was unchanged. That is, it is presumable that the carbohydrate flows from the source leaf firstly towards the growing leaves and the possible insufficiency hinders the growth of the root.

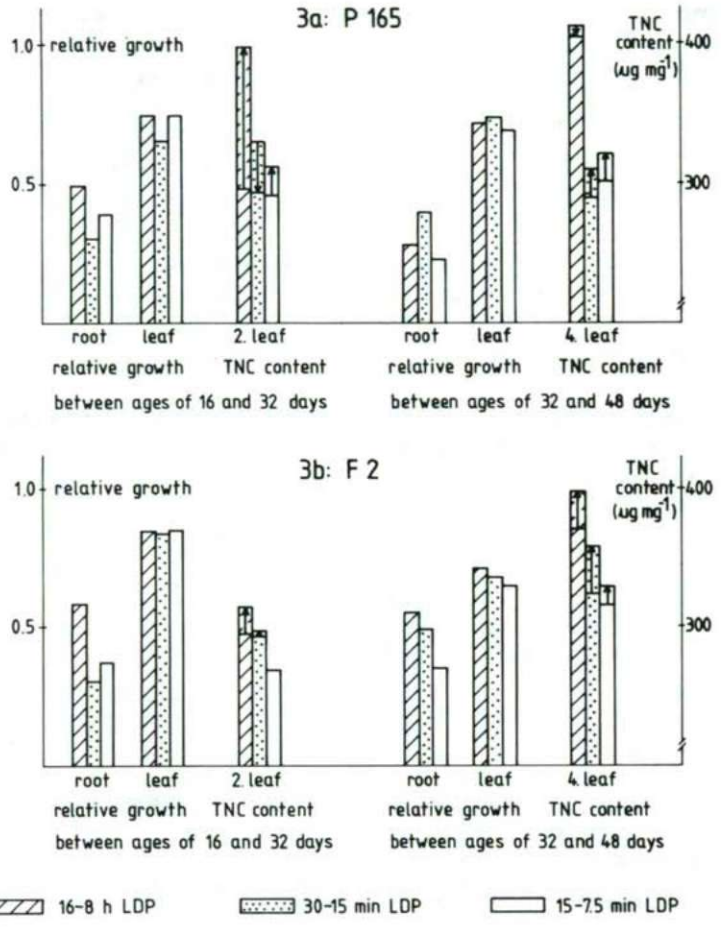

Fig. 3. Relative growth of the root and every leaf between the age of 16 and 32, as well as 32 and 48 days.
Relative growth = $(W_2-W_1)/W_2$ where W_1 = dry mass measured at beginning period
W_2 = dry mass measured at end of period
furthermore, the TNC (= soluble sugar + starch) content in the source leaf — 2. leaf between the age of 16 and 32 days and 4. leaf between 32 and 48 days of age — being the most characteristic of the two time periods. The direction and degree of the change in TNC content from the beginning till the end of the period is indicated by arrows. a: P165, b: F2.

Certain deviations from the foregoing could be experienced in the case of the P165 line in the 30-15 min. LDP: the high leaf TNC content and dry mass observed at the age of 16 days showed relatively slighter increase till 32 days of age, moreover there was a decrease in the TNC content (Fig. 3a). Reaching this age the carbohydrate flow from the seed had stopped and the earlier growth rate was not maintained by

the CO_2 assimilation. The relative growth (mainly of the root) was again found to be more intensive between the age of 32 and 48 days, but the TNC content of the 4. leaf was still low, but increasing in the given period, indicating the probably resatisfactory CO_2 fixation (Fig. 3a).

4. CARBOHYDRATE CONTENT IN THE BASAL AND APEX PARTS OF THE LEAF BLADE (Table 1)

There were firstly differences between the basal and apex parts of the blade of the studied maize leaves in the ratio of the soluble sugar and starch contents. The relative starch content was higher in the basic part of the leaf blade. Furthermore, the short LDP treatment was found to increase the relative starch content in general (cp. p8).

The relative starch content was higher in the case of the P165 maize in the 2. leaf while in the case of the F2 line, it was higher in the 4. leaf, particularly at the basal part.

Table 1.: Relative starch content in the basic and apex part of the studied leaves.
(Relative starch content $= \frac{\text{starch content}/\mu g\ mg^{-1}}{\text{TNC content}/\mu g\ mg^{-1}}$; LDP : Light-dark periods)

LEAF STAGE	LEAF AGE	LDP	P165 BASE	P165 APEX	P165 DIFF.	F2 BASE	F2 APEX	F2 DIFF.
2nd	developed	16–8 h	0.60	0.58	+0.02	0.61	0.58	+0.03
		30–15 min	0.69	0.71	–0.02	0.63	0.60	+0.03
		15–7.5 min	0.65	0.67	–0.02	0.61	0.61	0
	older	16–8 h	0.71	0.63	+0.08	0.65	0.58	+0.07
		30–15 min	0.74	0.70	+0.04	0.67	0.60	+0.07
		15–7.5 min	0.75	0.69	+0.06	0.66	0.59	+0.07
4th	developed	16–8 h	0.69	0.65	+0.04	0.78	0.61	+0.17
		30–15 min	0.70	0.60	+0.10	0.76	0.67	+0.09
		15–7.5 min	0.71	0.64	+0.07	0.74	0.65	+0.09
	older	16–8 h	0.68	0.58	+0.10	0.72	0.58	+0.14
		30–15 min	0.75	0.70	+0.05	0.78	0.64	+0.14
		15–7.5 min	0.72	0.69	+0.03	0.80	0.64	+0.16

Discussion

Our results proved the earlier observation according to which the P165 and F2 maize lines react differently to the short LDP treatment. The variancy-analysis demonstrated the interaction of the light-dark period and the genotype factor in the majority of the data on both dry mass and carbohydrate content. However,even in the case of the P165 maize more sensitive to the short LDP, several points were found where significant positive changes were detectable on the effect of the 30-15 min. LDP. (For example the starch content of the developed 2. leaf, the leaf-dry mass of the 16 days old plant). According to our assumptions, the different behaviour of the two maize lines at very young age is caused by the genetically varying transport and utilization of the seed reserves, later, however, the different photosynthesis of the leaves was determinative. The latter has been studied in detail by Pataki and Maróti (1985) in both maize lines with the finding that compared to the leaves of the F2 maize, in those of the P165 the quenching of the slow fluorescence is faster; the lag phase of the O_2 evolution is shorter; the ratio of the maximal oxygen evolution is higher; the violaxanthin de-epoxidation in the intrahylakoidal space is slower; furthermore the mesophyll chloroplasts contain higher amount of stroma membranes.

The comparison of the actual source leaf's TNC content and the growth showed that the relative growth of the leaves less depends on the carbohydrate content of the older leaves feeding them, however, that of the root is more dependent on this. The correlation is not on the whole unambiguous, other factors also play role. Such may be, for example, the enzyme function of the sucrose-phosphate-synthetase (HUBER et al. 1984), as well as the distribution of the inorganic phosphate in the cells (PREISS, 1982). It should be noted that (NAYLOR and GILES (1982) had also experienced the intensive growth of the young leaves of bean plants grown in short LDP, altough these were almost completely dependent on the photosynthates of the older leaves, owing to the considerable chlorophyll destruction.

Since the earlier studies refer to the fact the chloroplast membranes of the plants grown in short LDP have become disorganized (MARÓTI and TAKÁCS, 1983); the pigment content of the leaves has decreased (MARÓTI, 1982), and the energization of the chloroplasts is of slighter degree (TAKÁCS et al. 1985); it is presumable that the plants fix less CO_2 within the same period, i.e. they make less use of the light received during the short periods. To compensate this, they need increasing the ratio of the photosynthetizing/nonphotosynthetizing organs, similarly to the plants grown under less light intensity (BJÖRKMAN, 1982). Perhaps this is why the plant ensures the growth of the leaves even on the account of the root.

It is also observed that where the dry mass of the root is more reduced by the short LDP treatment, the dry mass of the whole plant is less reduced, perhaps even increased: in both lines at the age of 16 days; in the F2 maize at the age of 32 days. Thus the reduced dry mass ratio of the root could be regarded as an effectual phenomenon of adaptation. The mechanism of regulation responsible for the development of this has not been known yet, nevertheless the carbohydrate level of

the leaf probably plays role. It seems that the appropriate TNC level of the leaf means a potential possibility for the growth, however, this possibility prevails through mechanisms of regulation known only imperfectly at present.

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DÉGRADATION EXPÉRIMENTALE DES COLONIES DU GENRE *BOTRYOCOCCUS* DES SCHISTES PÉTROLIFÈRES DU TERTIAIRE SUPÉRIEUR DE HONGRIE

M. KEDVES

(Reçu le 25 Mars 1985)

Résumé

Nous avons mené des recherches expérimentales sur les colonies de *Botryococcus braunii* KÜTZ. des schistes pétrolifères de Pula (Hongrie). Une enzyme de *Helix* et du Mercapto-Ethanol ont été utilisés comme agents de dissolution pour attaquer partiellement et avec des intensités variables la paroi résistante des colonies de *Botryococcus* fossiles. Les observations ont été faits au MePh (microscope photonique) et au MeT (microscope électronique à transmission). Le MeT a permis de mettre évidence des unités globulaires de macromolécules ressemblant aux polymères de sporopollénine. L'arrangement de ces unités peut être en forme de filaments. L'application de cette méthode à des microfossiles végétales depuis le Précambrien jusqu'au sommet du Tertiaire permettra d'établir la phylogénie moléculaire de la paroi des microfossiles végétaux.

Mots clés: Tertiaire supérieur — schistes pétrolifères — *Botryococcus braunii* — dégradation experimentale — macromolécules.

Introduction

Dans un article précédent (KEDVES 1983), les associations sporo-polliniques et l'étude aux MePh et MeT de *Botryococcus braunii* KÜTZ. des schistes pétrolifères de quelques localitées de Hongrie ont été publiées. En ce qui concerne les colonies de *Botryococcus*, nous avons fait remarquer que leur couleur indiquait la présence de carotènes. Il est permis de supposer que ces carotènes ont été polymérisés en biopolymères, semblables à ceux de la sporopollénine. Pour définir la structure moléculaire des biopolymères de la paroi sporo-pollinique, on peut utiliser plusieurs méthodes. Les résultats de SENGUPTA et ROWLEY (1974), de ROWLEY (1975, 1978) et de ROWLEY et al. (1981) obtenus par l'utilisation de solvants et d'autres agents sont à mentionner en premier lieu. Une autre possibilité est la dégradation enzymatique. C'est ELSIK (1966,1971) qui a fait le point sur les problèmes les plus importants de la dégradation enzymatique des spores et des grains de pollen fossiles. Au cours de nos recherches palynologiques sur les sporomorphes de l'Eocène inférieur de Mississippi (États Unis) nous avons trouvé des exines de *Restioniidites hungaricus* (KDS. 1965) ELSIK 1968, partiellement dégradées. En étudiant la structure fine de ces exines sur les photos au MeT aux grossissements 500000 et 1 million, nous avons montré des unités globulaires de l'exine partiellement dégradées, qui sont probablement des polymères de sporopollénine. Pour obtenir des informations plus précises, nous avons essayé de dégrader la paroi pollinique de façon controllée pour mettre en évidence la structure moléculaire. En un premier temps nous avons

utilisé la méthode enzymatique. Cette méthode est largement utilisée dans préparation des protoplastes dans le cadre de recherches génétiques des microorganismes ou des organismes évolués. Les résultats des premières expériences, obtenus sur les grains de pollen du *Corylus avellana* L. actuel, concernant des problèmes généraux de ce type sont en cours de publication. Dans ce travail les premiers résultats sur la dégradation expérimentale de microrestes fossiles sont présentés.

Matériel et méthode

Les échantillons du sondage P-1928 de Pula (Hongrie) sont les mieux adaptés à ce genre de recherche. La préparation des échantillons a été faite, comme suit; attaque à l'acide nitrique, suivie d'un lavage; séparation par $ZnCl_2$, lavage; HF, lavage. Le résidu organique, et principalement des colonies de *Botryococcus*, été séché. Les traitements ont été fait sur du matériel séché. Les variantes des conditions d'expérimentation ont été combinées comme ci-dessous:

B.1.1. 20 mg de matériel séché de *Botryococcus* + 2 ml d'enzyme de Helix à 2% + 1 ml de Mercapto-Ethanol; température: 30 °C, durée de l'expérience: 2 heures et 30 minutes.
B.1.2. la même composition, sauf la durée de l'expérience: 5 heures.
B.2.1. 20 mg de matériel séché de *Botryococcus* + 2 ml d'enzyme de *Helix* à 2% + 20 µl de Mercapto-Ethanol; température: 30 °C; durée de l'expérience: 2 heures et 30 minutes.
B.2.2. la même composition, sauf la durée de l'expérience: 5 heures.
B.3.1. 20 mg de matériel séché de *Botryococcus* + 2 ml d'enzyme de *Helix* à 2%; température: 30 °C; durée de l'experience: 2 heures et 30 minutes.
B.3.2. la même composition, sauf la durée de l'expérience: 5 heures.
B.4a.1. 20 mg de matériel séché de *Botryococcus* + 1 ml Mercapto-Ethanol + 2 ml d'H_2O distillée, température: 30 °C; durée de l'expérience: 2 heures et 30 minutes.
B.4a.2. la même composition, sauf la durée de l'experience: 5 heures.

En fin de traitement, le résidu est lavé plusieurs fois à l'eau distillée. Pour les études au MeT, la post-fixation à l'OsO_4/eau-distillée a été utilisée pour l'infiltration d'araldite (Durcupan, Fluka).Les lames ont été montées avec de l'araldite pour les observations au MePh. Il faut remarquer que l'araldite convient bien pour conserver les objects microscopiques sous la lamelle. Les photos au MeT ont été prises au Laboratoire de Microscopie Electronique de l'Université J.A. de Szeged, sur un microscope électronique Tesla BS-500 (résolution 6 Å).

Résultats

Au cours et à la fin des traitements les changements de la couleur et de la consistance du matériel sont des signes d'altérations. Les résultats des études au microscope optique ont fourni des indications concernant le degré de dégradation des colonies de *Botryococcus* (Planche I, fig. 1–8, fig.1). Parmi les colonies, il y en a qui, au microscope optique, sont en bon état de conservation (Planche I, fig. 1–3). D'autres sont partiellement (Planche I, fig. 4,5), ou complétement dégradées (Planche I, fig. 7,8). La figure 6 de la Planche I, représente une colonie ou quelques zones sont presque homogénéisées, et d'autres apparemment conservées en état originel. En ce qui concerne les résultats quantitatifs des colonies in vitro dégradées à des degrés différents, nous pouvons faire les remarques suivantes:

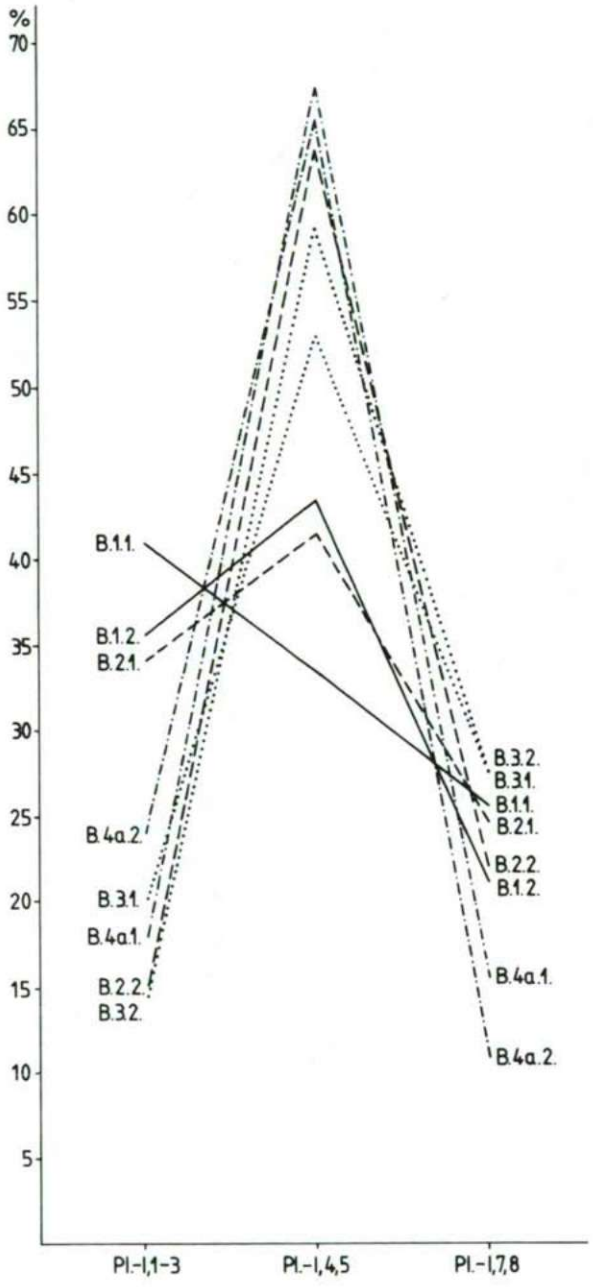


Fig. 1

Pourcentages des colonies de *Botryococcus braunii* KÜTZ. à trois degrés de dégradation suite à des traitements différents. Pl.-I, 1-3 = Planche I, fig. 1-3, Pl.-I, 4,5 = Planche I, fig. 4,5, Pl.-I, fig 7,8 = Planche I, fig. 7,8.

1. La dégradation de la paroi des colonies a eu lieu quel que soit le type de traitement employé. Le Mercapto-Ethanol, sans enzyme, est tout aussi actif pour dégrader les colonies de *Botryococcus*.

2. Selon les diverses variantes de nos expériences, on note des différences. A première vue, il semble que le traitement B.1.1., diffère des autres en laissant intacte la plus grande partie des colonies. A partir de B.1.2. les courbes sont complétement différentes, les maximums de dégradation se trouvent au centre et on peut constater une augmentation graduelle. Les pourcentages de colonies partiellement dégradées après B.2.1. et B.1.2., n'atteignent pas 45%; après B.2.2., B.4a.1., et B.4a.2. ils dépassent 60%. Les maximums de B.3.1. et B.3.2. se situent entre 50% et 60%.

Les résultats au microscope électronique à transmission sont les suivants:

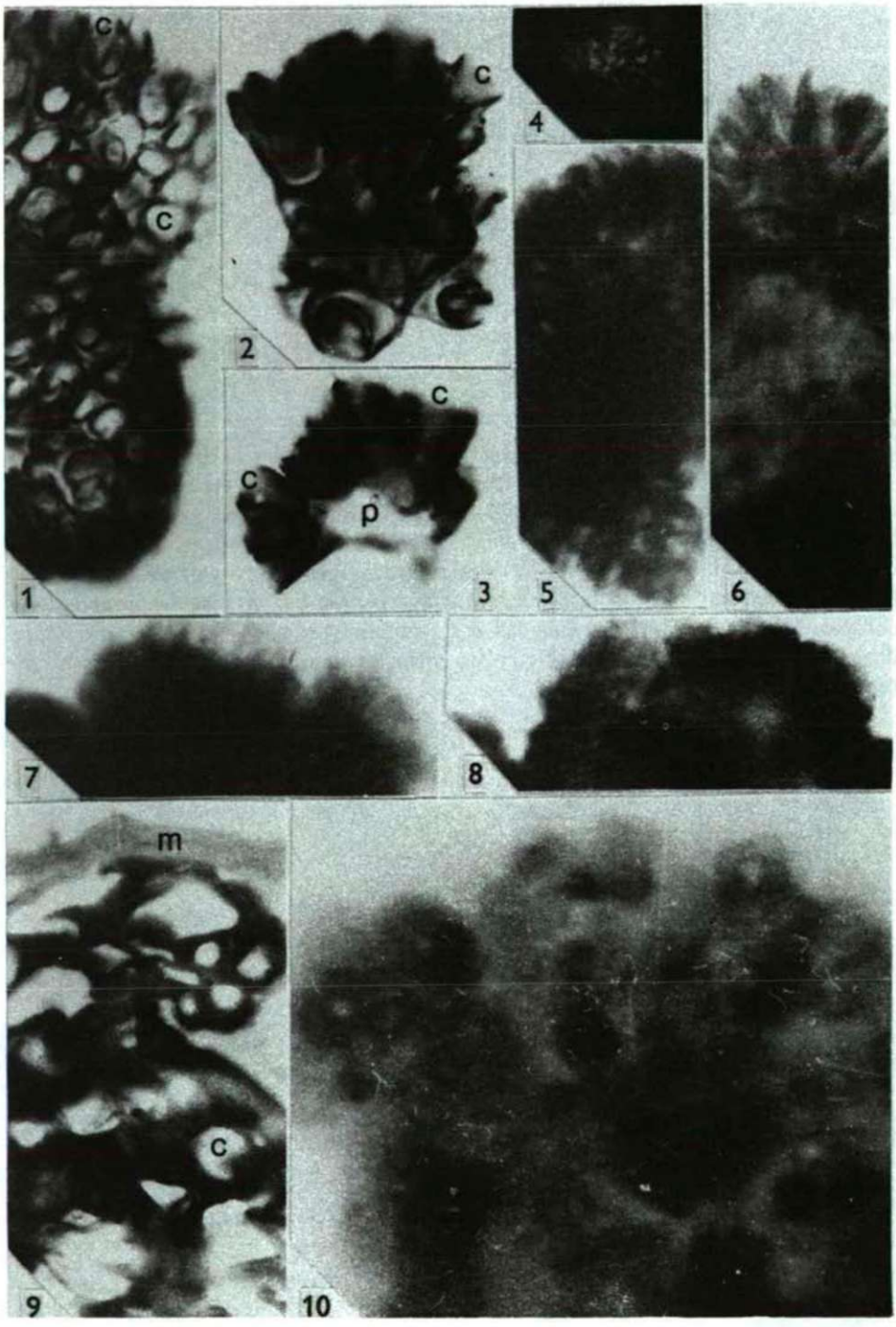
B.1.1. L'ultrastructure originale des colonies qui semblait intacte au microscope photonique peut être observée. Le mucilage lamellaire est ici beaucoup plus visible que chez les exemplaires qui n'ont pas subi de traitement spécifique (KEDVES 1983, planche 1, fig.7). Les unités de polymères ont pu être observées là où la paroi des colonies était localement corrodée. Les signes de début de dégradation sont plus marqués, quand une zone plus ou moins grande située sous la surface a une affinitée électronique plus forte que la partie interne. Les colonies attaquées à des degrés divers sont les plus propices à l'étude de la morphologie et de la disposition des unités de polymères. Il y a des éléments sphériques arrangés en filaments ou en résaux. Les unités sont composées, en général, de cinq sous-unités décrites par ROWLEY (1967) à la base des grandes épines du grain de pollen de *Nuphar luteum*. Selon ROWLEY (1967) il s'agit de „fibrilles tubuleuses". Dans notre cas, ce ne sont probablement pas des fibrilles, mais la ressemblance entre les photos de ROWLEY (1967) et les notres est frappante; nous appelerons ces éléments „unités de ROWLEY" en hommage à Monsieur J. ROWLEY.

Planche I

1–8. Colonies de *Botryococcus braunii* KÜTZ. à divers stades de dégradation au MePh. Le résidue a été monté à l'araldite, après préparation à l'OsO_4/eau dist. Il faut noter que les pédoncules des colonies ont moins accepté l'osmium que les cupules, x500.

1. Prép. B.1.1.–2; 2.7/116.8
2. Prép. B.3.2.–2; 1.6/109.2
3. Prép. B.4a.1.–1; 11.2/102.5
4. Prép. B.2.1.–2; 7.4/102.6
5. Prép. B.3.1.–1; 20.5/111.2
6. Prép. B.3.1.–1; 7.3/109.2
7. Prép. B.1.2.–2; 12.6/112.2
8. Prép. B.1.1.–2; 7.8/119.4
9. B.1.1., MeT, section tangentielle d'un colonie "dite intacte", x25000.
10. B.1.1., MeT, "unités de ROWLEY" d'une colonie dégradée, x250000.

c = cupule, p = pédoncule, m = mucilage


c
c
1
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2
c
c
p
3
4
5
6
7
8
m
c
9
10

B.1.2. Les colonies „dites intactes" ont une affinitée électronique plus forte; les stries noires qui marquent la phase initiale de la dégradation se répandent partout. La dégradation est avancée, en particulier sur les lamelles du mucilage; les unités globulaires sont bien observables. Il faut remarquer, que la paroi qui à l'origine est compacte, devient lamellaire par suite de la dégradation. Il y des colonies très dégradées où le MeT, permet d'observer la structure fine originelle complètement désorganisée.

B.2.1. Les colonies „dites intactes" et celles dégradées sont identiques à celles de B.1.2.

B.2.2. Parmi les colonies „intactes" au MePh, nous avons pu observer deux types: B.1.1. et B.1.2.. Sur les coupes ultraminces, des unités globulaires et des „unités de ROWLEY" ont été observées.

B.3.1. Les colonies „intactes" ressemblent à celles de B.1.2., mais rarement à celles de B.1.1.. Les éléments des polymères des colonies dégradées, rappellent celles de B.2.2.

B.3.2. et B.4a.1. sont essentiellement identiques à celles de B.3.1.

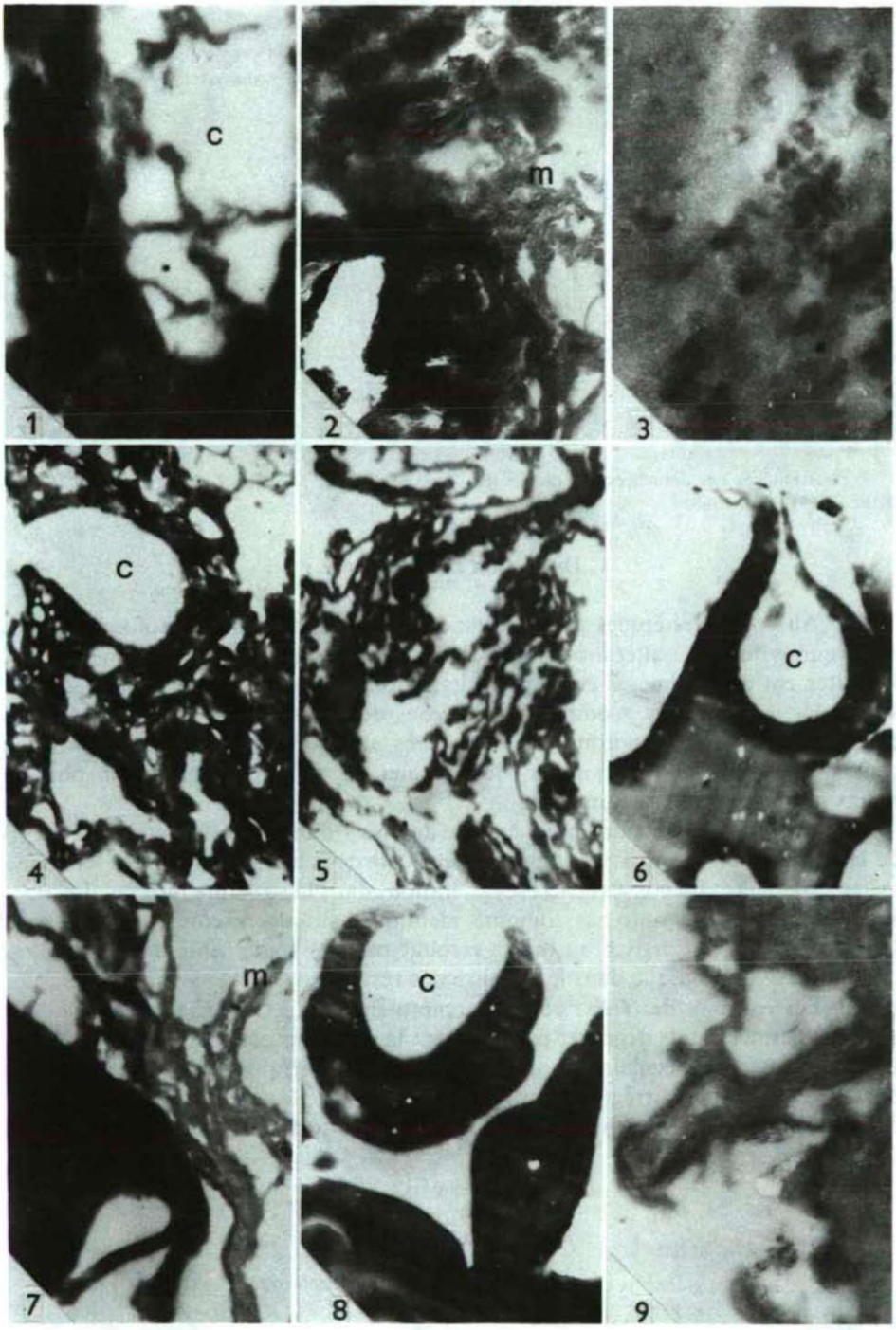
B.4a.2. Parmi les „colonies intactes" on a pu observer les types B.1.1., et B.1.2., mais leur dégradation est en général plus avancée. Il y a beaucoup d' éléments lamellaires et fibrillaires. Les macromolécules sont ici plus visibles. On a mesuré le diamètre des polymères: 7 à 14 Å. Les pourcentages de polymères de différents diamètres sont indiqués sur la fig. 2.. Nous avons ajouté la courbe des pourcentages comparables de *Restioniidites hungaricus*, en se basant sur des recherches antérieures de KEDVES et al. (1974). Les différences entre les deux sorte de microfossile sont remarquables.

Planche II

Botryococcus braunii KÜTZ.

1. B.1.2.,MeT, détail d'une cupule partiellement dégradée, au milieu du mucilage; les éléments de l'ultrastructure sont homogénéisées, x25000.
2. B.1.2., MeT, la dégradation est importante mais les éléments du mucilage sont visibles, l'homogénéisation des cupules est nette, x25000.
3. B.1.2., MeT, éléments des "unités de ROWLEY" d'une colonie très dégradée, x100000.
4. B.2.1., MeT, détail de l'ultrastructure d'un colonie presque intact, x5000.
5. B.2.2., MeT, éléments lamellaires d'une colonie partiellement dégradée, 5000.
6. B.3.2., MeT, phase initiale de la dégradation des colonies de type B.1.1., x5000.
7. B.3.2., MeT, éléments du mucilage extérieur et partie d'une cupule, x10000.
8. B.4a.1., MeT, phase initiale de dégradation des colonies de type B.1.2., x5000.
9. B.4a.1., MeT, détail d'une colonie fort dégradée; l'ultrastructure originelle n'est plus observable, x5000.

c = cupule, m = mucilage


c
m
1
2
3
c
4
5
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6
m
c
7
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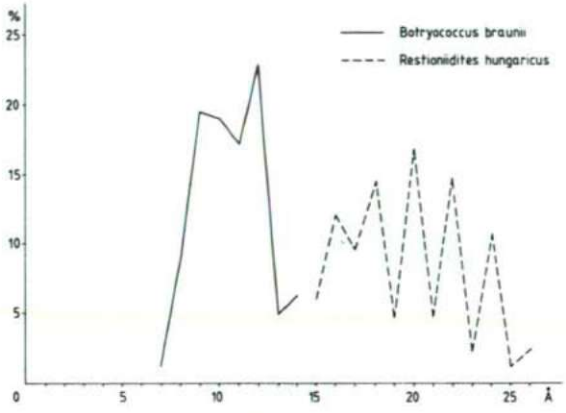


Fig. 2

Pourcentages des diamètres des polymères sphériques de *B. braunii* KÜTZ. et de *R. hungaricus* (KDS. 1965) ELSIK 1968.

Discussion et conclusions

1. Au cours des études de dégradation expérimentale des microfossiles, nous remarquons que, si les altérations moléculaires débutent au cours de la sédimentation, le traitement des sédiments et les produits utilisés pour le MeT peuvent également altérer les microfossiles. Comme nous l'avons déjà fait remarquer (KEDVES 1985) dans certains cas, les sporomorphes observés au MePh sont apparemment bien conservées, mais l'observation au MeT permet de voir une dégradation plus ou moins partielle de la structure fine.

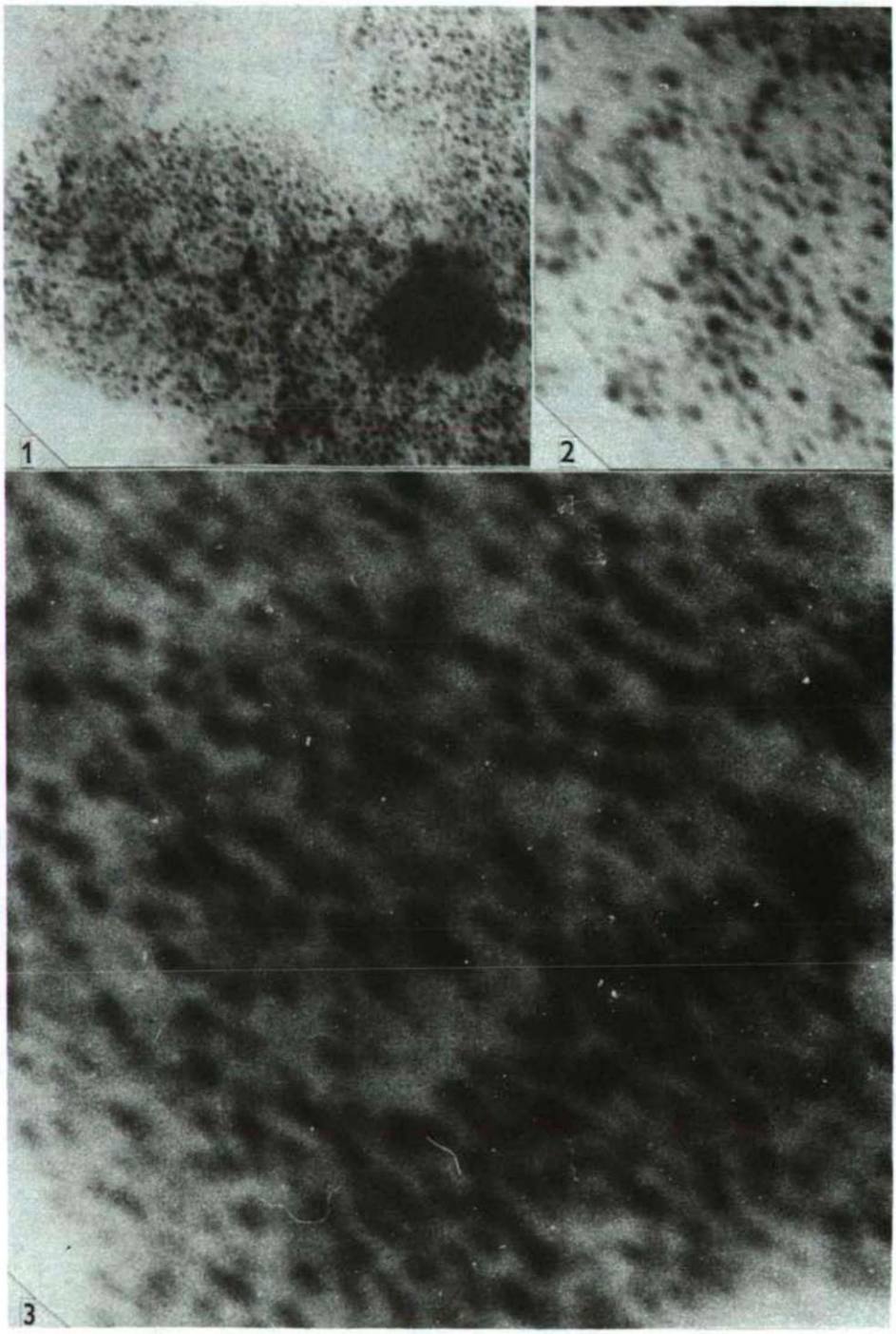
2. Les résultats obtenus indiquent, qu'au cours du traitement l'effet des agents de la dégradation n'est pas toujours le même sur des colonies différentes lors de la même expérience. En conséquence, les altérations dans la structure moléculaire, dues à la fossilisation ne sont pas toujours identiques sur des exemplaires différents. Cependant, on peut arriver au même résultat par des traitements différents, ainsi que nous l'avons indiqué dans le chapitre des résultats.

3. Les enzymes de *Helix*, ou le Mercapto-Ethanol, et le mélange de ces deux produits permettent de dégrader partiellement la paroi des colonies de *Botryococcus*. Les unités macromoléculaires sont globulaires, mais l'arrangement de ces éléments peut être filamenteux, irrégulier, etc. Il est curieux, que le résultat le plus visible ait été obtenu par le traitement B.4a.2., au Mercapto-Ethanol uniquement, sans

Planche III

Botryococcus braunii KÜTZ.

1–3. B.4a.2., éléments globuleux des macromolécules à des grossissements différents.
1. x100000, 2. x250000, 3. x500000.


1
2
3

l'enzyme de *Helix*. Il faut mentionner que la paroi compacte peut être lamellaire par suite d'une dégradation partielle (cf. AFZELIUS 1956).

4. Il faut soulingner la nécessité de continuer recherches sur les polymères des sporomorphes fossiles. En obtenant ainsi des informations supplémentaires, on peut espérer établir des rélations phylétiques de la structure macromoléculaire de la paroi des sporomorphes et des cystes ou d'autres restes organiques.

Remerciements

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IN VITRO DESTRUCTION OF THE EXINE OF RECENT PALYNOMORPHS I

M. KEDVES

(Received March 21, 1985)

Abstract

During our investigations on recent and fossil pollen grains and other plant microfossils (e.g. *Botryococcus braunii* KÜTZ., extracted from oil shale), the wall structure was degraded enzymatically under in vitro experimental conditions. On the basis of our first results we have established the following: 1. *Helix* enzyme with merkapto-ethanol is suitable to decompose the sporopollenin of recent and fossil plant microfossils. 2. The partially decomposed wall, studied by the TEM method, may reveal the molecular structure of the sporopollenin. 3. Our results on recent *Corylus avellana* L. pollen grains suggest a globular structure of the biopolymers of the sporopollenin of this species.
Key words: Corylus avellana, sporopollenin, molecular structure

Introduction

„Sporopollenins are probably the most resistant organic materials of direct biological origin found in nature and in geological samples" (BROOKS and SHAW, 1978, p.91). The chemistry of this material has been the subject of several studies. The first results were published by JOHN (1814) and BRACONNOT (1829). ZETZSCHE et al. (1931), ZETZSCHE and KÄLIN (1928), KWIATKOWSKI and LUBLINER-MIANOWSKA (1957), and MÄDER (1958) published further data. These first results were rewieved by TOMSOVIC (1960) and it was emphasized that sporopollenin is a high-polymerized terpene derivate, similar to cutin. The results of SHAW and YEADON (1964) and BROOKS and SHAW (1968a,b) fundamentally changed this concept, and the importance of carotenoids was emphasized in the composition of sporopollenin. SHAW (1971) wrote as follows; p.305: „sporopollenins are oxidative polymers of carotenoids and/or carotenoid esters". As regards the enzymatic degradation of the exine, the publications of ELSIK (1966, 1971) are worth mentioning. In 1971 he emphasized the following: „Microbial degradation of sporopollenin which results in definite patterns or scars is attributable to higher bacteria (*Actinomycetes*) and true fungi". Biological (enzymatical) destruction as a method in the research of the molecular structure of sporopollenin was not yet used. The first observations of microbial destruction of the pollen wall were published by ERDTMAN (1971). During the ontogeny of the pollen wall HORVATH (1969) and FLYNN and ROWLEY (1971) demonstrated acid phosphatase reaction. FAEGRI (1971) p.261 wrote: „Sporopollenin may be no exception, to enzymatic degradation, but at the moment we do not know

very much about these enzymes which are able to digest this material. I was charmed by the idea presented at the Symposium by HESLOP-HARRISON that the final stages in the formation of sporopollenin may be a non-enzymatic reaction, which suggests that there are no enzymes able to reverse the process if the chemical equilibrum is disturbed." KEDVES et al. (1974) recognized the molecular structure of degraded exines from Eocene of Mississippi, USA. A globular structure of the sporopollenin was established, moreover it was established, that „new studies and experiments will be carried out on this subject" (p. 436). SENGUPTA and ROWLEY (1974) and ROWLEY (1975, 1978) published the concept that the exine consists of filamentous subunits (cf. ROWLEY 1962a, b; ROWLEY, DAHL, SENGUPTA and ROWLEY, 1981). The motto of this last mentioned paper is greatly appreciated; „Between 'yes' and 'no' there are possible answers, less abrupt more fruitful" – HEISENBERG – .

Taking into consideration the above mentioned results and different concepts, we carried out our experimental studies on recent and fossil palynomorphs. This paper summarizes the first our results in this field.

Material and Methods

Fresh pollen grains of *Corylus avellana* L. were collected on 11 March in 1984 in the Botanical Garden of the J.A. University by I. GYURICZA and I. DÁVID. The pollen material was placed into dark glass containers to avoid autoxidation of the sporopollenin. The first experiments were made on 17 April 1984. The experimental methods are essentially those employed for the preparation of protoplasts for further experimental studies (DAVIS, 1985, PEBERDY, 1985). We tried the following procedures:

C–1 – 20 mg. air dried pollen grains + 2 ml *Helix* enzyme 2%, temperature 30 °C, length of time: $2^h30'$.
C–1A – the same only the lenght of time was 5^h.
C–2 – 20 mg. air dried pollen grains + 2 ml *Helix* enzyme 2%, + 1 ml merkapto-ethanol, temperature 30 °C, length of time : $2^h30'$.
C–2A – the same only the length of time was 5^h.
C–3 – 20 mg. air dried pollen grains + 2 ml *Helix* enzyme 2%, + 1 ml merkapto-ethanol + 20 mg. EDTA, temperature 30 °C, lenght of time: $2^h30'$.
C–3A – the same only the length of time was 5^h.

The procedures of the second experiments (15th May, 1984) were as follows:

C–4 – 20 mg. air dried pollen grains + 20 ml H_2O dest., temperature 30 °C, length of time: $2^h30'$.
C–4A – the same only the length of time was 5^h.
C–6 – the same as C–1.
C–6A – the same as C–1A.
C–8 – 20 mg. air dried pollen grains + 2 ml *Helix* enzyme 2%, + 20 µl merkapto-ethanol, temperature 30 °C, length of time: $2^h30'$.
C–8A – the same only the length of time was 5^h.
C–10 – 20 mg. air dried pollen grains + 2 ml *Helix* enzyme 2%, + 20 µl merkapto-ethanol + 20 mg. EDTA, temperature 30 °C, length of time: $2^h30'$.
C–10A – the same only the length of time was 5^h.

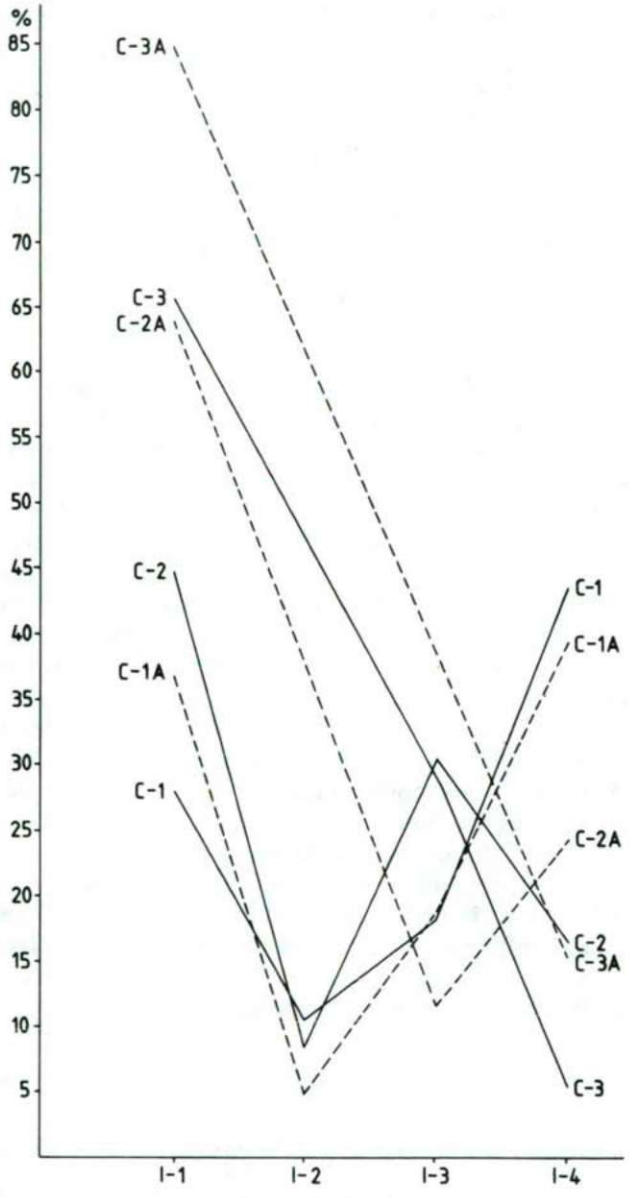

Fig. 1

The percentage of different forms of *Corylus avellana* L. pollen grains; experiments: C–1, C–1A, C–2, C–2A, C–3, C–3A. I–1 = empty, typical pollen grains, I–2 = pollen grains which are full of protoplasm, with small oncus, I–3 = pollen grains with normal size range onci, I–4 = pollen grains full of protoplasm, without oncus, pro parte near protoplast.

The procedures of the third experiments (26th September, 1984) were as follows:

C–4c.1 – 20 mg air dried pollen grains + 1 ml merkapto-ethanol + 2 ml H_2O dest., temperature 30 °C, length of time: $2^h30'$.
C–4c.2 – the same only the length of time was 5^h.

The pollen material was fixed on OsO_4 (aqu. dil.) and embedded in Araldite (Durcupan, Fluka). For LM investigations, pollen grains in Araldite were mounted on slides. The ultra-thin sections were made on a Porter Blum ultramicrotome with glass knives. The TEM photomicrographs were taken on a TESLA BS–500 instrument, which has a resolution of 6 Å.

Results

1.The most important changes of pollen grains as a result of enzymatic activity were followed by the LM method (Plate I, fig.1–4). Several types and forms, apart from the basic form of *Corylus* pollen, which is triaperturate with a triangular equatorial outline, may be distinguished. From the point of view of our research the „near protoplast" is important (Plate I, fig.4). The exine of this kind of pollen grain is very thin, without stratification, lacks the apertural exine, and the form is globular. To prepare this pollen form, procedures no. C–2, and C–2A were succesful. The quantitative proportions of the different forms, following the three series of experiments are figured on fig. 1–3, but the last type represents all pollen grains which are full of protoplasma. Fig. 4 represents the per cents of the „near protoplast" sensu stricto, and all other pollen grains, which are full of protoplasm. A regularity may be established, and on the basis of the present results the middle values are important in respect of the investigation of the molecular structure of the sporopollenin. Moreover a protoplasma/enzyme interaction may be presumed to occur during the exine degradation.

2. On the basis of the TEM data we may establish the following:

C–1 (Plate I, fig. 5) In the ultrastructure of the pollen grains, there is no obvious destruction. The exine is as has been described in earlier papers (channeled tectum, irregular or granular infratectum, no endexine under the foot layer except the apertural area). In the protoplasm the small oncus in the apertural region is characteristic and the finely lamellar intine is thin.

Plate I

LM and TEM pictures from pollen grains of *Corylus avellana* L. experimented upon.

1–4. Light microscopic pictures of the different pollen forms of *Corylus avellana* L. x1000.
1. Empty pollen grain, typical form; C–1.
2. Pollen grain full of protoplasm, with small oncus, typical form; C–1.
3. Onci are within normal size range; C–1A.
4. Almost naked protoplast, lacks the apertural exine, and the pollen wall is extremely thin, degraded; C–2.
5. TEM picture. The non-degraded ectexine, the oncus (0), and the protoplast are shown; C–1, x5000.


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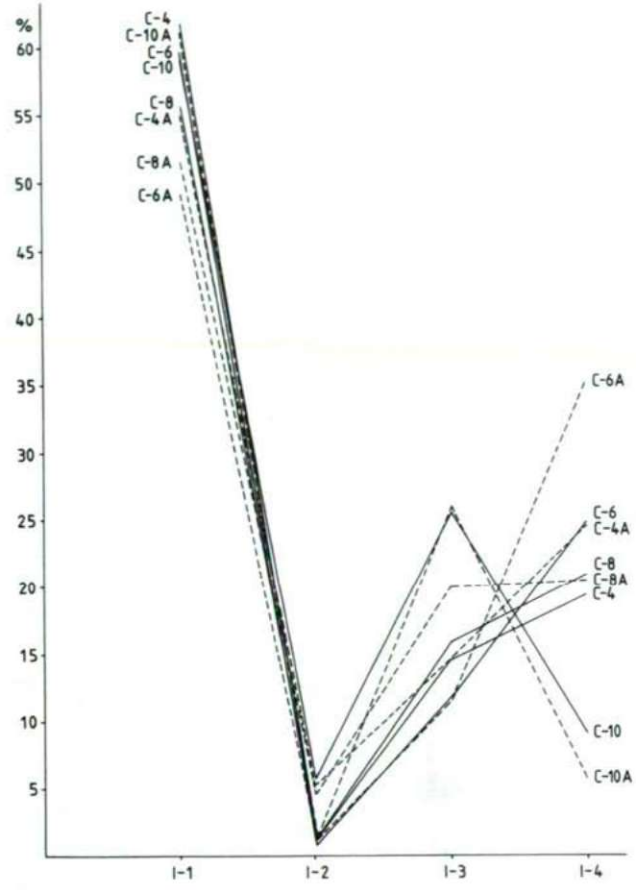


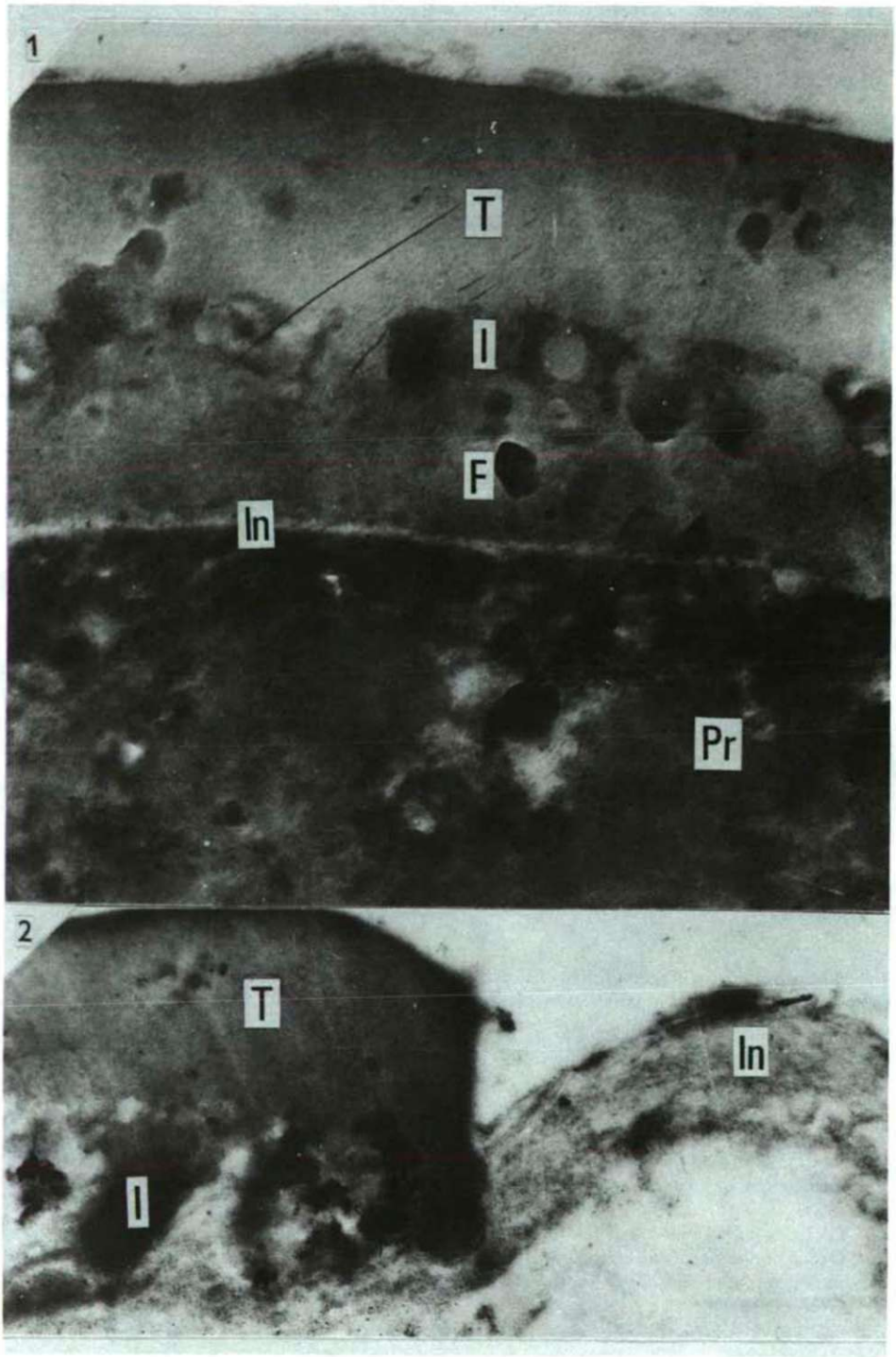
Fig. 2

The percentage of different forms of *Corylus avellana* L. pollen grains; experiments: C–4, C–4A, C–6, C–6A, C–8, C–8A, C–10, C–10A. I–1 = empty, typical pollen grains, I–2 = pollen grains which are full of protoplasm, with small oncus, I–3 = plasmolysed pollen grains, I–4 = pollen grains full of protoplasm, without oncus, pro parte near protoplast.

Plate II

TEM pictures.

1. Detail from the inter-apertural exine, including: the tectum (T), the infratectal layer (I), the foot layer (F), the very thin intine (In), and the protoplasm (Pr). The degradation of the infratectal layer is shown, channels were not observed in the tectum; C–1A, x100000.
2. Ultrastructure of the apertural intine (In). The lamellar ultrastructure is shown; C–2, x50000.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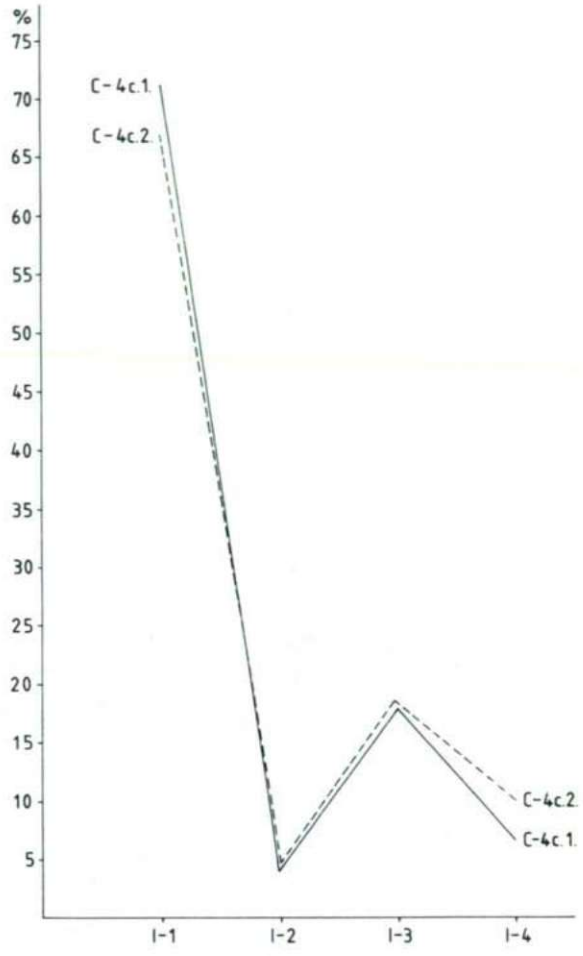
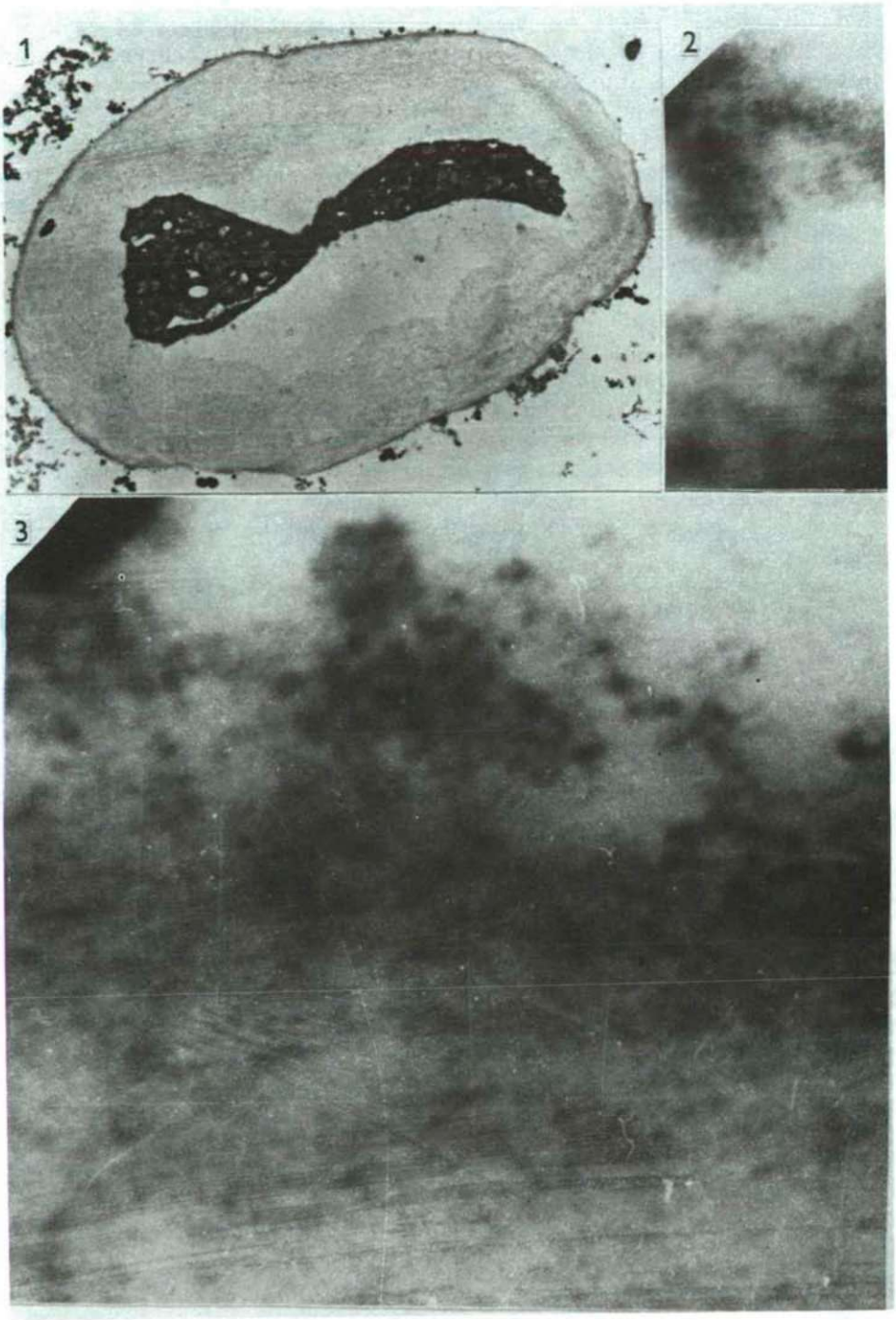


Fig. 3

The percentage of different forms of *Corylus avellana* L. pollen grains; experiments: C–4c1, C–4c–2. I–1 = empty, typical pollen grains, I–2 = pollen grains which are full of protoplasm, with small oncus, I–3 = plasmolysed pollen grains, I–4 = pollen grains full of protoplasm, without oncus, pro parte near protoplast.

Plate III

1. Ultrastructure of an almost naked protoplast of *Corylus* pollen, showing the remainder of the ectexine, and the lack of the apertural area. There is a lamellar ultrastructure is present under the ectexine remains, similar to the intine. The degradation of the protoplasm is also shown; C–2A, x5000.
2. Globular units of sporopollenin from the specimen illustrated on fig.1; C–2A, x100000.
3. Detail of the above mentioned enzyme degraded ectexine. Illustrated are the remnants of the infratectum and the foot layer, the globular sporopollenin units of the ectexine are well shown; C–2A, x500000.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C–1A (Plate II, fig.1) An interesting partial degradation of the exine was observed firstly on the infratectal layer. It is also interesting, that channels were not observed on these preparations. During the ontogenesis of the ectexine, in the first stage of its development, the probacules appear, e.g. the infratectal layer, and afterwards the tectum.

C–2 The above mentioned partial degradation is more definite. The apertural area lacks the inner, lamellar endexine, but the pore-covering lamellar intine is not degraded (Plate II, fig.2).

The most important results were obtained by experiment C–2A. On microphotograph 1 of Plate III, two important things may be observed: 1. The ectexine degradation is the final stage; it is very thin and without stratification. 2.The degradation of the protoplasm is well shown and a relatively thick layer with lamellar ultrastructure is present, similar to the intine. Several pictures were taken with high magnification of this degraded part of the exine, and in this way globular units were observed of 8–13 Å in diameter (Plate III, fig. 2,3).

C–3 and C–3A experiments gave heterogeneous results, it seems, that EDTA is not advantageous for the degradation of sporopollenin.

The most important results of the second and third series of experiments are as follows:

C–4 and C–4A — No alterations in the fine structure of the exine.

C–8A and C–10 — Partial degradation of the ectexine was observed, in particular in the infratectum, and the channels of the tectum were also not observed; cf. C–1A.

C–10A — Globular units were observed in several thin sections. Worth of mentioning is, that the merkapto-ethanol without *Helix* enzyme have degraded only in insignificant degree the exine of the *Corylus* pollen. The channels of the tectum were not observed, and the degradation of the endexine in the apertural region was also observed.

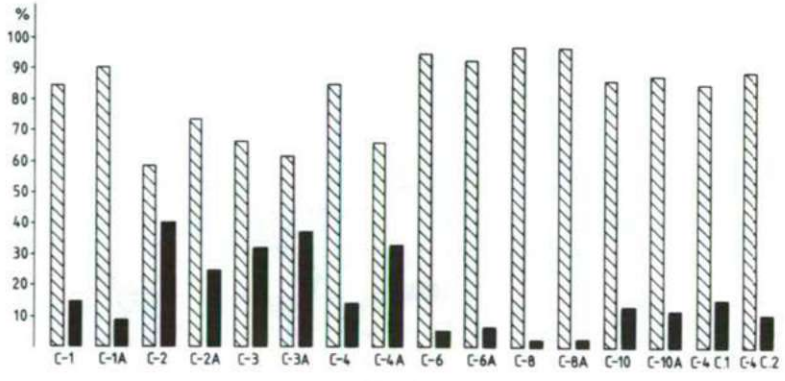

Fig. 4

The per cents of the almost naked protoplast — black column -, and all other pollen grains, which are full of protoplasm; streaked column.

Discussion and conclusions

1. As new result we emphasize that *Helix* enzyme with merkapto-ethanol is suitable for the destruction of the ectexine. In this way, combined with the TEM method, the molecular structure of sporopollenin may be demonstrated. Taking into consideration the digestion of *Helix pomatia* it may be presumed that this method will be useful in the research of the molecular structure of all kinds of plant cell walls.

2. We found globular units for the polymers of sporopollenin, but non-granular units are well shown on several pictures of ROWLEY, DAHL and ROWLEY (1980,1981), and of ROWLEY (1981). But on the other hand, in several aspects their results are similar to ours, e.g.: ROWLEY (1967), ROWLEY, DAHL, SENGUPTA and ROWLEY (1981). Probably the basic elements are globular, and these elements may be arranged into units of higher order; filaments, helicoide structures, etc.

3. Because during all experiments there is the risk that the observed structures have been altered during the experiment or the preparation for the TEM investigations. Further experiments of different kinds are necessary on both recent and fossil biological objects before we can understand the details of the molecular structure of the sporopollenin.

Acknowledgements

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EFFECT OF 6-HYDROXY-DOPAMINE ON THE FLUOROGENIC MONOAMINE CONTAINING NERVE ELEMENTS IN THE FORE-GUT MUSCULATURE OF *HELIX POMATIA*

É. FEKETE

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Abstract

Using glyoxylic acid induced fluorescence method an intensive green fluorescence characteristic to catecholamines was observed on nerve fibres with varicosities, nerve bundles and perykaryons on wholemounts stretch preparates of snail's gut.

On the effect of 6-hydroxy-dopamine (6-OHDA) administered intracardially (2.5 mg/animal) the amount of fluorescent nerve elements were significantly reduced. 48 hours after the injection of 6-OHDA practically no fluorescent fibres were seen. However several cell bodies showing intensive green fluorescence were detectable during the 72 hours of experimental periode.

Key words: fluorescence, catecholamines, 6-hydroxy-dopamine, snail

Introduction

Glyoxylic acid (GA) has been found to be suitable for the histochemical demonstrations of biogenic monoamines (AXELSSON et al. 1973). It was shown that GA induced fluorescence (GIF) is specially very sensitive for the demonstration of catecholamines in peripheral adrenergic nerves (FURNESS and COSTA, 1974). The use of a different combination of GIF techniques the wholemounts preparates of intact ganglia (MARSDEN and KERKUT, 1970) and a number of peripheral tissues such as the heart, prostate gland, salivary gland (BARBER, 1983) provided valuable information on the localization of nerves, cell bodies and axons having associated biogenic monoamines. By the use of sucrose-phosphate-glyoxylic acid (SPG) technique (DE LA TORRE and SURGEON, 1976) on wholemount stretch preparates of snail's gut, the distribution of fluorogenic monoamines containing nerve elements were followed in the whole length of snail alimentary tract (FEKETE, 1984), and three segments were revealed concerning the amount of fluorescent nerve elements and also the fluorescence intensity. It is likely from pharmacological studies (TRIMBLE et al., 1984) that among catecholamines in Mollusc only dopamine acts as neurotransmitter. However preliminary biochemical (HALASY et al. 1985) and some physiological (KAZACHENKO et al. 1978) investigations demonstrated that both adrenaline and noradrenaline are present in snail's gut and may act as neurotransmitters or neuromodulators. However noradrenergic axons have often been identified by their ability to take up noradrenaline analogues, such as 5-, or 6-hydroxydopamine (COSTA et al. 1976, DREYFUS et al. 1977, FURNESS and COSTA, 1974), the literature concerning

the selectivity and the mode of action of 6-OHDA is very contraversary. It is well documented that 6-OHDA causes degeneration in the mammalian adrenergically innervated organs (PORTER et al. 1963, THOENEN and TRANZER, 1968), due to degeneration of their noradrenaline terminals. The typical degenerative changes seen in mammalian adrenergic neurons after 6-OHDA treatment could not be detected in Octopus peripheral nerves (MARTIN and BARLOW, 1975). An investigation on different Mussel neurons (ELEKES et al. 1977) showed that different part of mussel's neurons have different sensitivity to 6-OHDA. In the central nervous system of *Planorbis corneus* a giant dopaminergic cell (GDC) was identified, in which 6-OHDA caused an increased catecholamine-specific fluorescence (BERRY et al. 1974).

To clarify the effect of 6-OHDA in the enteric nerves of *Helix pomatia* we followed the nerve elements surrounding blood vessels in the fore-gut of the snail and evaluated the differences in the fluorescence intensity and the number of fluorescent nerve elements before and after intracardially administered 6-OHDA.

Materials and Methods

Helix pomatia used in these studies were collected over the period of April to October. Seasonal changes in the intensity of histofluorescence were not observed during this period.

For the histochemical detection of biogenic monoamines the SPG method (DE LA TORRE and SURGEON, 1976) was applied to wholemount stretch preparates of snail's gut. The digestive tract were quickly dissected and incubated in a reaction mixture containing 6.8 g sucrose, 3.2 g KH_2PO_4 and 1 g glyoxylic acid (GA) in 100 ml of distilled water, at 4 °C for 15 minutes. The muscular layer of the gut wall was then stretched on microscope slides, blotted with blotting paper and dried under cool air for about 1/2 hour. Finally the specimens were placed in an oven at 95 °C for 4 min. and mounted with liquid paraffin. The preparations were viewed through a Leitz Ortoplan microscope equipped with indirect illumination and an HBO 50W super pressure mercury lamp. An E-3 filter block was used to observe induced fluorescence. Black and white photographs were taken on FORTE-PAN 400 film. To follow the effect of 6-OHDA, 6-OHDA HCl (Sigma) was administered intracardially. The 6-OHDA was dissolved in 0.1 ml of saline (NaCl 0.65%; KCl 0.015%) and was administered as one dose of 2.5 mg/animal. The animals were killed and processed for histochemical detection of fluorogenic monoamines after 2, 24, 48 and 72 h of injection.

Results

In the untreated controls (Fig.1–3., Fig.8.) the fluorescence was bright and well localized in the fore-gut. Fluorescent fibres showed a characteristic arrangement around blood vessels and these part of the specimens were the most comparable in the whole length of the fore-gut. Fluorescent fibres occurred singly or in bundles and were concentrated in several areas (Fig.1., 8.). Most of the single fibres were varicous (Fig. 1–2., arrowheads). Fibres running along the vessels divided at some places and made connections with neighboring nerve trunks. Single cells with bright fluorescence were also seen. Most of them were in close association with nerve trunks (Fig.1., 2. arrows). Processes of these cells could be followed on the surface of the

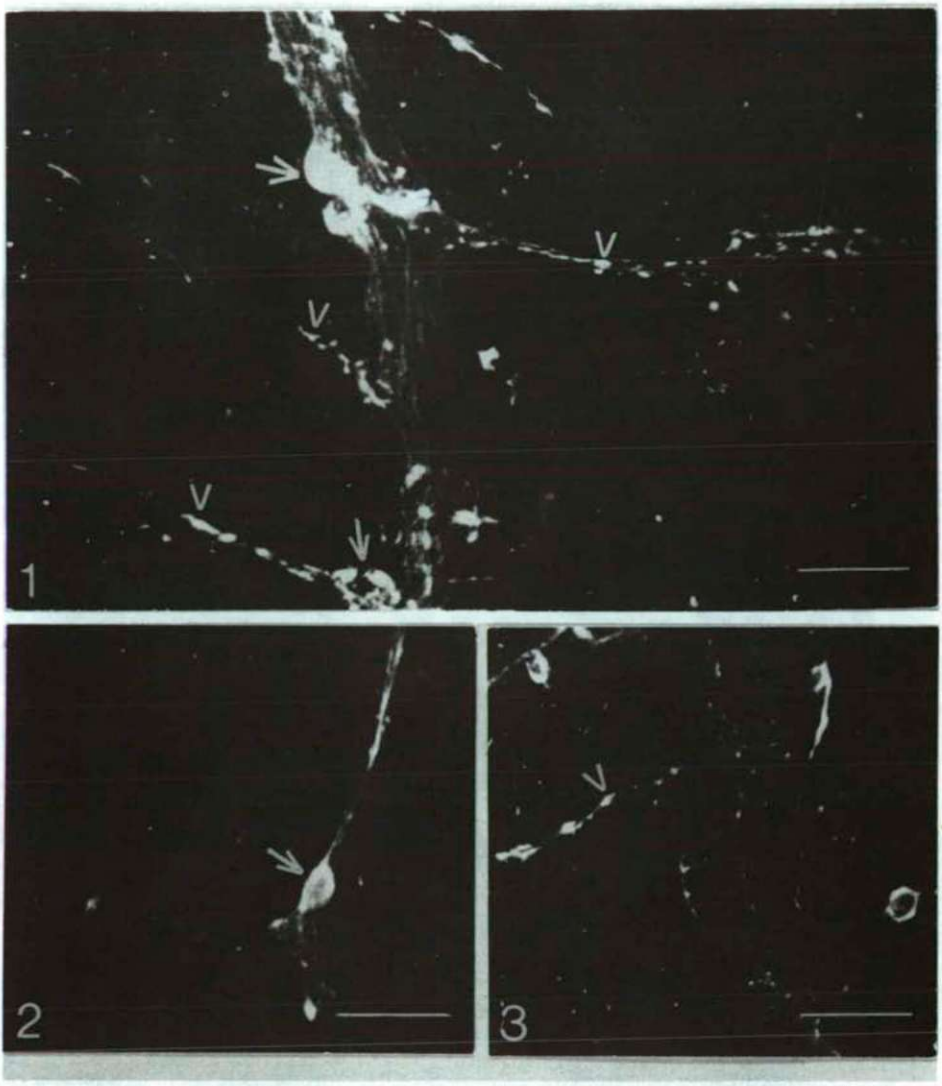


Fig. 1. **Glyoxylic acid-induced fluorescence in whole-mount stretch preparates in the snail's fore-gut musculature. Arrows indicates cell bodies, arrow-heads varicosities. Scale bar: 50 μm**

Fig. 2. Fluorescent cell bodie in the fore-gut (arrow) being in close connection to nerve trunks. Scale bar: 50 μm

Fig. 3. Single cells of different sizes and shapes in the fore-gut with no visible connection to the bundles. In the neighborhood of these cells randomly oriented varicous fibres (arrows-head) are running. Scale bar: 50 μm

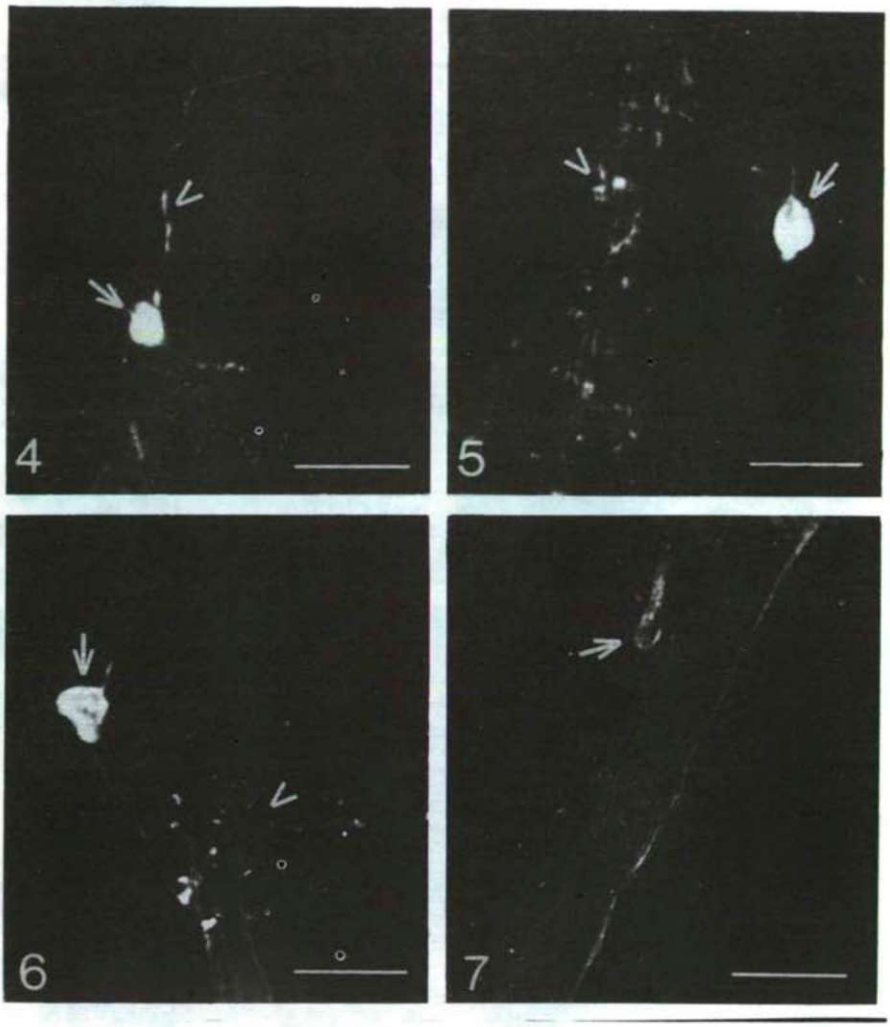
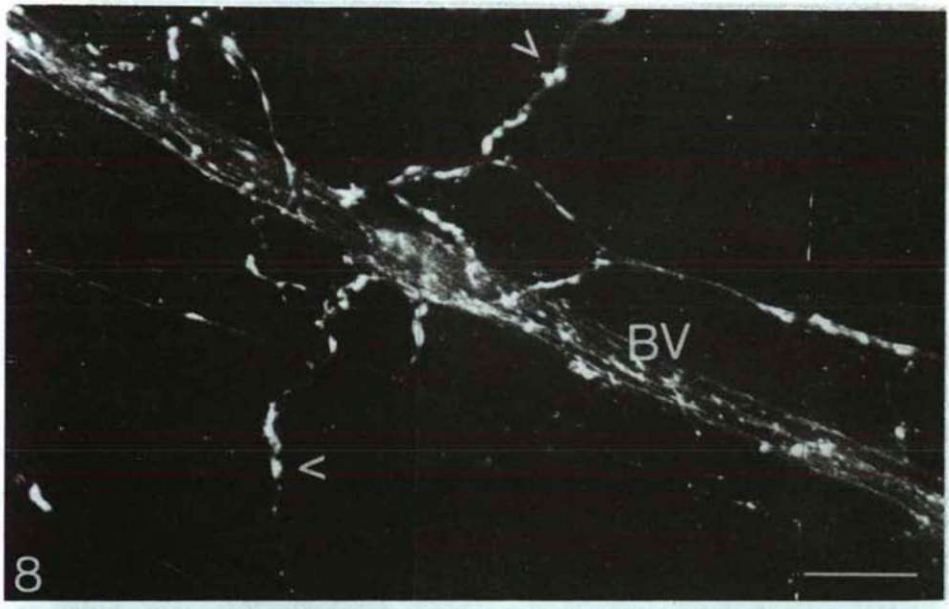


Fig. 4. Fluorescent nerve cell bodie after 24 hours of 6-OHDA treatment in snail's fore-gut. The cell processes show varicosities (arrow-head). Scale bar: 50 μm

Fig. 5. Varicouse fibres are concentrated at several areas after 48 hours of 6-OHDA treatment. Intensively fluorescent cell bodie (arrow) running parallel to the fibres. Scale bar: 50 μm

Fig. 6. After 72 hours of 6-OHDA treatment varicous fibres (arrow-heads) and intensively fluorescent cell bodie (arrow) still can be seen at several areas in the fore-gut. Scale bar: 50 μm

Fig. 7. After 72 hours of 6-OHDA treatment some of the remaining cells (arrow) show much reduced fluorescence. Scale bar: 50 μm



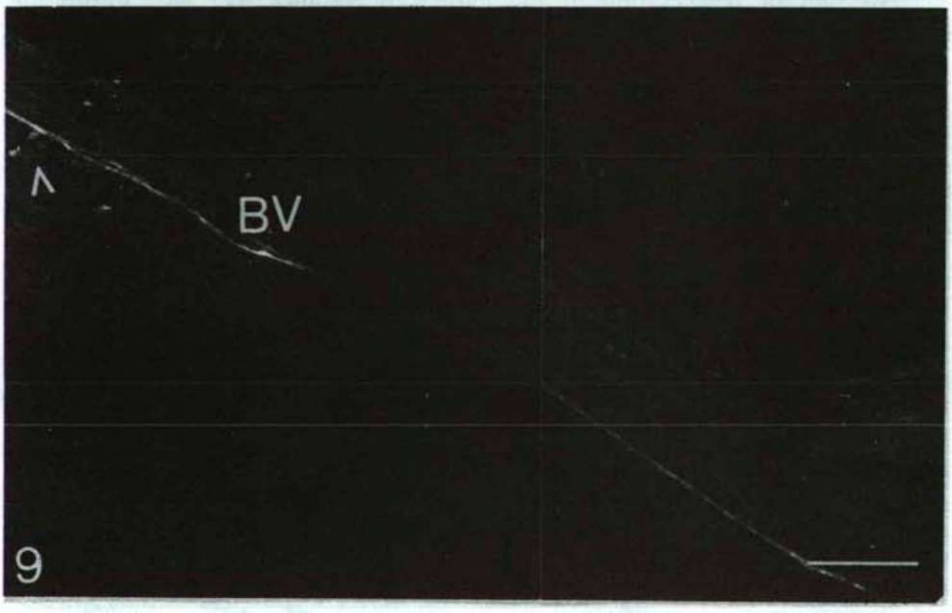


Fig. 8. Whole mount of fore-gut showing the characteristic pattern of cathecolamine containing nerve fibres along the blood vessels (BV) before 6-OHDA treatment. Scale bar: 50 μm

Fig. 9. Blood vessel in the snail's fore-gut after 72 hours of 6-OHDA treatment. Some faintly fluorescent fibres (arrow-head) can only be seen in the biggest part of the fore-gut. Scale bar: 50 μm

vessels. Single cells showing a less intense fluorescence appeared a little farther with no visible connection to the nerve bundles (Fig.3.). The GIF in the perykarya of these cells was usually restricted to the cytoplasm.

Most of the speciemens prepared from 6-OHDA treated animals could be separated from the controls on a single blind bases (Fig. 8., 9.). However 2 hours after 6-OHDA treatment there was no visible changes neither in the intensity nor in the amount of fluorescent nerve elements. 24 hours after the drug treatment most of the fluorescence disappeared (Fig. 4–7., 9.). The rest of the fibres showed an irregular distribution and the fluorescence intensity was reduced comparing to the untreated samples. All of the remaining fibres were short and varicous in appearance (Fig. 4–6., arrowheads). After additional 24 hours practically there was no change in the GIF (Fig. 6.). While 72 hours after the 6-OHDA treatment a further decrease in the fluorescent nerve elements and fluorescence intensity was observable (Fig. 7., 9.). In these specimens a very few faintly fluorescent fibres were only seen on the surface of the vessels (Fig. 9.). Some of the cells with a very intense GIF having close connection to the vessels „survived" the 6-OHDA treatment and revealed a very intense catecholamine fluorescence within the whole experimental periode (Fig. 4–6.). In some cells the fluorescence intensity was dropped by 72 hours of treatment (Fig. 7.).

No sign of regeneration in the fluorescent profiles was seen during the experimental periode.

Discussion

The use of GIF technique on wholemount stretch preparates of gut musculature in *Helix pomatia* allowed us to map the distribution of aminergic nerve fibres and related cells in different segments of alimentary tract (FEKETE, 1984). Since the fluorescent network was most pronounced in the fore-gut (FEKETE, 1984) and was most comparable around the blood vessels this segment of the gut was used to follow the effect of 6-OHDA. The main finding of the present work was that 6-OHDA treatment resulted a significant decrease in the fluorescent intensity and the number of fluorescent nerve elements. Although a characteristic time-pattern appeared in the degeneration processe of CA nerves within the experimental period. Some of the cells being in close connection to vessels were not sensitive to drug treatment at all. The processes of these cells could be followed along the blood vessels and also several thin, varicous fibres were seen neighboring the cells. From these findings we assumed that different cells and connected fibres have different sensitivity to the neurotoxin 6-OHDA which is known to be specific for noradrenergic nerve elements (THOENEN and TRANZER, 1983). We have several alternative explanations for this phenomenom (HÖKFELT and UNGERSTEDT, 1973; FURNESS and COSTA, 1980). These cells may not contain noradrenalin but some other kind of monoamines which are not sensitive to the drug. This alternative is supported by data (BERRY et al. 1974) which showed up increased catecholamine-specific fluorescence in identified dopamine-containing cells after 6-OHDA treatment. We consider a possible higher

catecholamine level of these cells as an other explanation. This can cause a delayed exchange rate between the toxin and the fluorogen amine. This alternative is partly supported by data from the literature (LLEWELLYN et al. 1981), and also favored by our finding after 72 hours of 6-OHDA accumulation. Some of the cells showed very intense fluorescence after 48 hours of treatment but lost fluorescence intensity by 72 hours of treatment. The third possibility is that the selective amine pumpe present on adrenergic nerves and having an active role in monoamine and their antimetabolites uptake is missing from these cells.

Biochemical and ultrastructural investigations are in progress to decide the validity of these possible explanations.

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ELECTRONMICROSCOPIC ANALYSIS OF THE CYTOPATHOLOGICAL EFFECT OF PESTICIDES IN THE LIVER, KIDNEY AND GILL TISSUES OF CARP

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Abstract

The cytopathological effect of the sublethal doses of paraquat, Ultracid 40 WP and copper sulphate was studied in the liver, kidney and gill tissues of carp with the help of electronmicroscopic method. After two weeks the Ultracid 40 WP produced expansive cell damage in the liver parenchyma cells, the paraquat did not produce significant cytopathological effect, however, the copper sulphate resulted a decrease in the heterochromatin substance of the nuclei. In the majority of the cell organelles the paraquat caused expansive degenerative alterations in the exocrine pancreas. All three agents displayed cell-damaging effect in the kidney tissue, contrary to this, alterations referring only to slight cell damage developed in the gill. Our observations call attention to the fact that pesticides and their residues found in our fish-ponds and natural waters imply potential toxic danger on the fish of the waters.
Key words: fish, cytopathology, pesticides

Introduction

In Hungary 20–30 times severe fish perish occur annually as the consequence of water pollution. About one third of the water pollutions is due to chemicals used in agriculture (SZAKOLCZAI and MOLNÁR, 1978). Despite the fact that the pesticides dangerous to fish can be used within 200–500 meters from the banks of living waters only with permission of sanitary authorities, unfortunately the frequency of fish perish has not decreased in the recent years. Although the cause of the fish perish cannot always be traced back to a single factor (NEMCSÓK et al. 1981; NEMCSÓK, 1983), from the factors the toxic effect of pesticides almost always plays a significant role, the presentation of which is often due to the fact that certain tissues of fish accumulate the pesticides and their residues to an enormous degree (REICHENBACH-KLINKE, 1972; SALÁNKI et al. 1982). For this very reason the water chemical measurement data which prove that actually there are no pesticides present in higher concentrations than permissible in a given water are not reassuring in spite of this, as the consequence of the coincidence of certain unfavourable environmental factors (continuos warming up, lack of wind, etc.) fish perish may occur (NEMCSÓK, 1983). A further potential danger is that occasionally rainfalls may wash a large amount of pesticide into the waters from the plough lands. In such case temporarily a pesticide amount producing toxic effect may even get into the waters, however, the toxic values are generally not detected due to the rare water samplings.

All these circumstances propound the necessity to follow the „sanitary conditions" of the fish living in our waters with even greater attention, and to take the necessary measures in due time. At present the „arsenal" of fish hygiene is rather scant in Hungary. Practically, there is no regular veterinary control anywhere; recently a histopathological survey started at the Lake Balaton and occasional biochemical studies were also performed (BENEDECZKY et al. 1984; HORVÁTH and STAMMER, 1979; NEMCSÓK et al. 1981; SALÁNKI et al. 1982). In situ studies can well be complemented by laboratory experiments where besides the determination of the Lc50 values, the effect of the sublethal doses of pesticides can also be well studied in respect to the various physiological processes of the fish, furthermore, with which biochemical or histopathological parameters these patho-physiological alterations can be characterized. Starting from tnese possibilities the objective of the present study aimed at investigating the cytopathological alterations produced by the sublethal doses of paraquat, Ultracid 40WP and copper sulphate in the certain vital organs of carp (gill, liver, kidney) following 2 weeks' exposure, with the help of electronmicroscopy.

Materials and Methods

Our experiments were performed on lacustrian carp (*Cyprinus carpio* L.), originating from the breed of the Fish-Hatchery Research Institute in Szarvas. The fish weighed 850–1000 g. Prior to the experiment the fish were habituated to aquarium for 7–14 days. Three individuals were kept in a 100 l sized aquarium. The water temperature was 10 °C all throughout the experiment. The animals were not fed during the two weeks' treatment period. Treatment with pesticides was carried out by dissolving the chemicals in the aquarium water. The final concentration of the effective agents was set to 5 mg/l of paraquat, 2 mg/l of Ultracid 40 WP and 5 mg/l of copper sulphate. During the course of the experiment the water of the aquaria was freshened by air insufflation.

For the purpose of electronmicroscopic study tissue samples were taken following an exposure of 2 weeks. The fish were numbed by blows on the head, then the abdominal cavity opened and 1 mm^3 pieces cut from the liver, kidney and gill using a sharp safety razor. The specimens were fixed in 2.5% glutaraldehyde for 2–24 hours at 4 °C . The pH of the fixative was set to 7.3 with cacodylate buffer. Following fixation the samples were washed for 5 minutes in 7.5% saccharose-ontaining cacodylate buffer. Then the tissue blocks were further fixed in 2% OsO_4 solution for 2 hours in dark, at 4 °C . The pH of the OsO_4solution was buffered to pH: 7.3 value with s-collidine. The dehydration was performed on ascending ethyl alcohol series. The blocks were further contrasted in 75% ethanol with saturated uranyl acetate solution for 30 minutes in dark. The samples were embedded in Durcupan ACM. The ultrathin sections were only „stained" with lead citrate according to the method of REYNOLDS. The electronmicroscopic pictures were prepared on TESLA BS 500 electron microscope.

Results

ELECTRON MICROSCOPIC STRUCTURE OF THE UNTREATED CONTROL CARP LIVER, KIDNEY AND GILL

LIVER: A large nucleolus of loose structure is detectable in the light karyoplasm of the nucleus, poor in heterochromatin (Fig.1). In the cytoplasm of the hepatocytes a great number of moderately electron dense mitochondria can be seen, being in

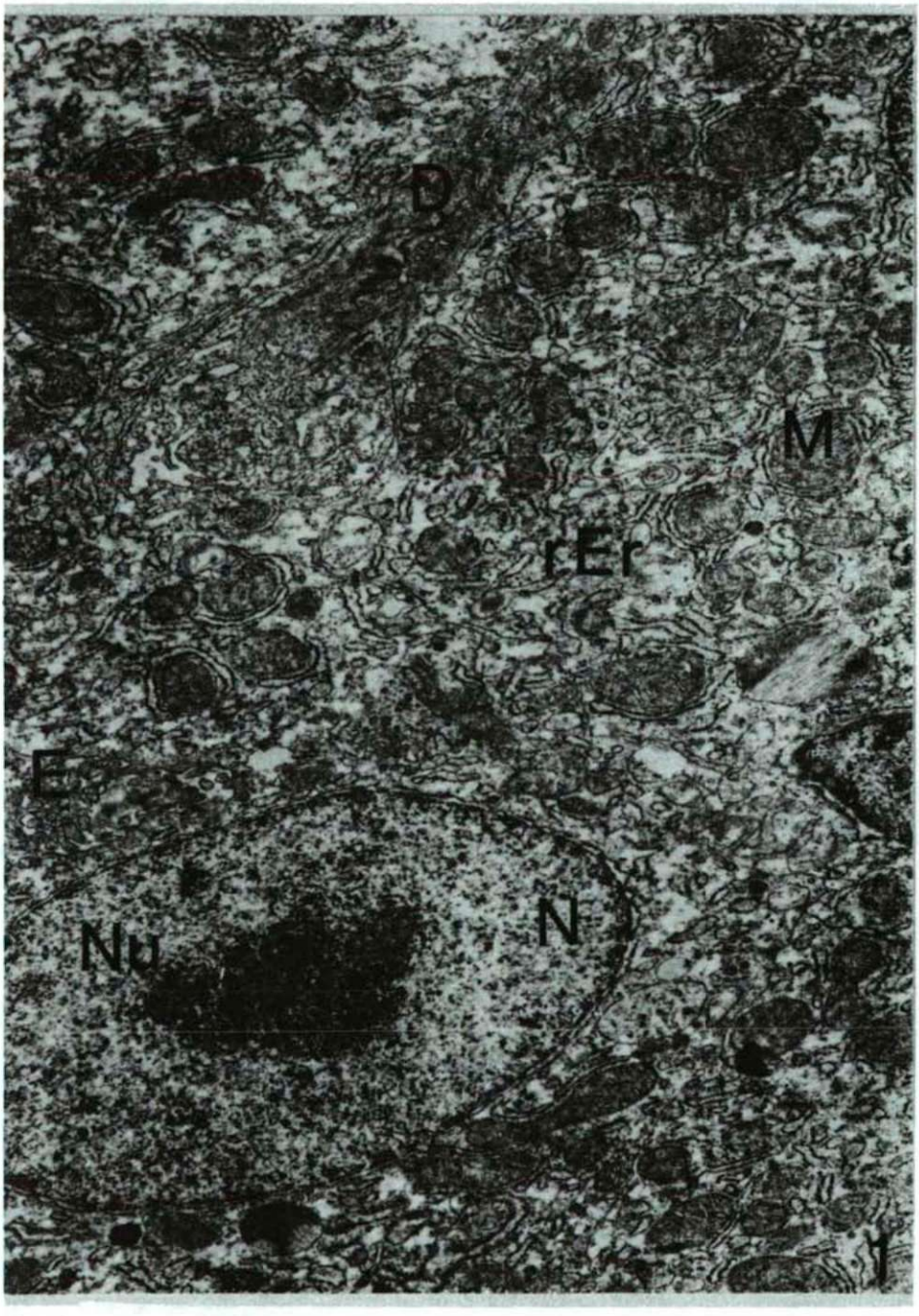

Fig. 1.
Detail of hepatocyte from the liver tissue of untreated carp. Large nucleolus (Nu) and few chromatins are observable in the nucleus (N). The cytoplasm contains many mitochondria (M) and abundant rough surfaced endoplasmic reticulum (rEr) substance. E = bile canaliculus; D = bile duct.
x 18.000

tight morphological contact with the slightly dilated rough surfaced endoplasmic reticulum. A bile canaliculus is situated in the neighbourhood of the nucleus. Few lysosomes and bile pigments also occur in the cytoplasm of the parenchyma cells.
KIDNEY: Microvilli of regular arrangement form the brush-border at the apical pole of the epithelial cells of the kidney tubuli. Cilia cross-sections are also observable in the lumen of the primary convoluted renal tubules (Fig.2). A rather high amount of electron dense endocytotic vesicles can be observed at the apical pole of the tubular epithelial cells. Lysosomes of varying shape and electron density can be found below them. The nucleus has basal location, its karyoplasm contains a significant amount of heterochromatin. A large number of mitochondria and a few lipid droplets can also be detected in the cytoplasm of the epithelial cells.
GILL: Moderately electron dense nucleus can be found in the pillar cells of the branchial lamellae (Fig. 3). Mitochondria, rough surfaced endoplasmic reticulum tubuli and some lysosomes are observable in the relatively narrow cytoplasm. Generally a high amount of erythrocytes occupy the capillary lumen. The pillar cells are limited by broad basal lamina.

ELECTRONMICROSCOPIC STRUCTURE OF CARP LIVER, KIDNEY AND GILL TISSUES AFTER TREATMENT WITH PESTICIDES

LIVER: No striking ultrastructural changes were observed in the structure of the nucleus following paraquat-treatment and the structure of the mitochondria as well as the rough surfaced endoplasmic reticulum substance were similarly well preserved, too (Fig. 4).

The cytoplasm contained a considerable amount of bile pigments besides the high number of glycogen granules. Both filamentous substances and electron dense granular material were present in the matrix of the bile pigments (Fig. 4). Other alterations referring to cell damage were not observed in the liver tissue. On the contrary, focal cell damage was detected in the tissue of the exocrine pancreas situated in the direct neighbourhood of the liver tissue (Fig. 5). Large myelin figures developed in the glandular cells. The tubules of the rough surfaced endoplasmic reticulum became dilated as cisternae. The cytoplasmic vacuoles occurring in large numbers could also be evaluated as a degenerative alteration. The shape, size and inner electron density of the zymogen granules were rather divergent as well, even in the case of one and the same glandular cell (Fig. 5).

Following treatment with Ultracid 40WP striking ultrastructural alterations developed in the hepatocytes. The most obvious was the formation of light and dark cells, in each of which cytopatological alterations were detectable. Similary to the paraquat, ultrastructural alterations referring to the effect of the agent were not observable in the nucleus. Large autophage vacuoles were frequently seen in the cytoplasm (Fig. 6), and relatively intact mitochondria circumscribed by membranes were found in them. Numerous ribosomes could be observed on certain intravacuolar membranes, referring to the early stage of autophagy. At the same time it was striking that the majority of the mitochondria had well preserved structure in these

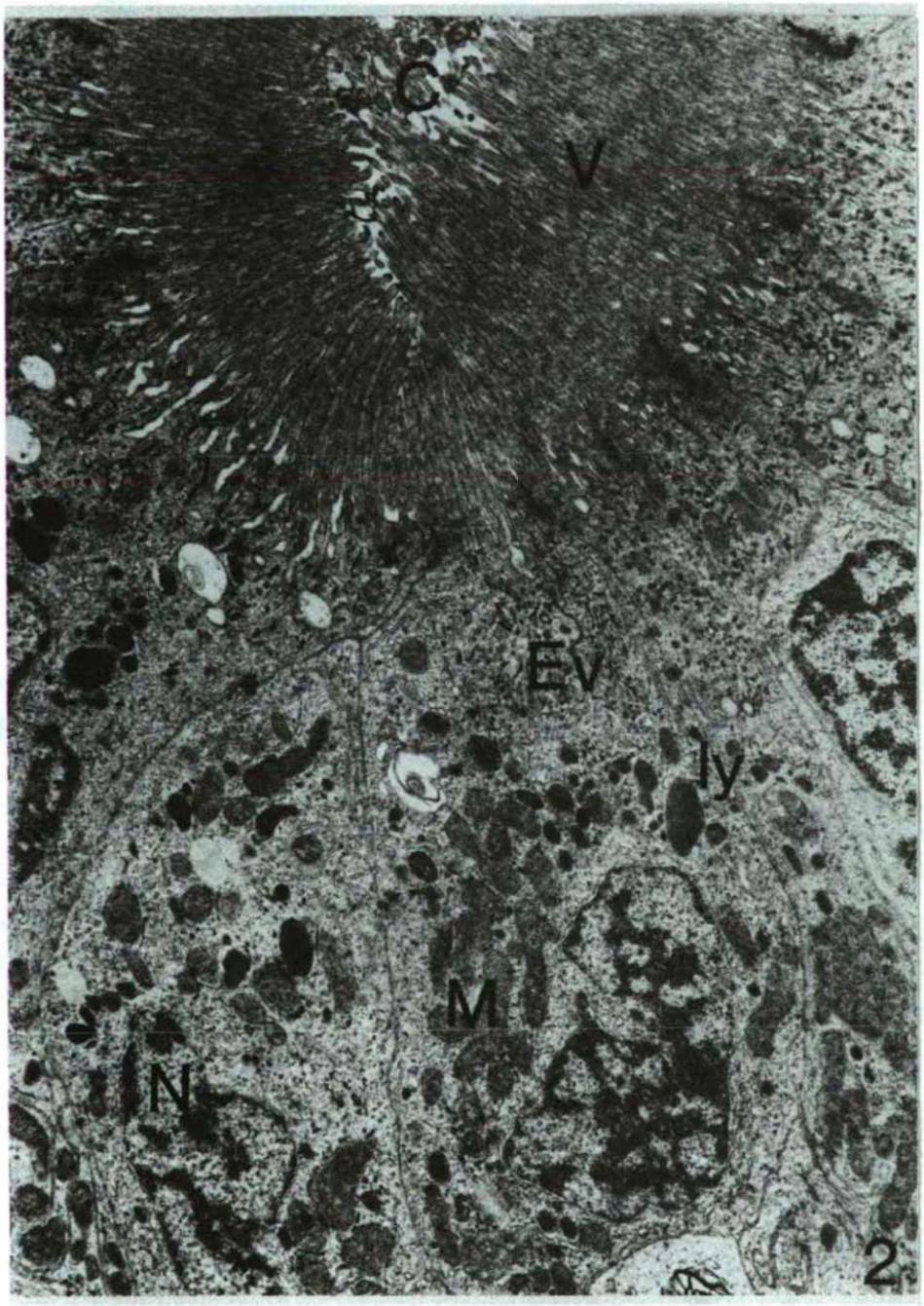

Fig. 2. Untreated carp kidney, primary convoluted renal tubules. Microvilli of regular structure (V) and some cilia (C) cross-sections can be seen on the tubular epithelial cell surfaces. Many endocytotic vesicules (Ev) and lysosomes (ly) occur in the parenchyma cells. N: nucleus; M: mitochondrium.
x 12.000

Fig. 3. Untreated carp gill. Erythrocytes (Er) fill in the lumen of the capillaries (C). P: pillar cell; N: nucleus.
x 12.000

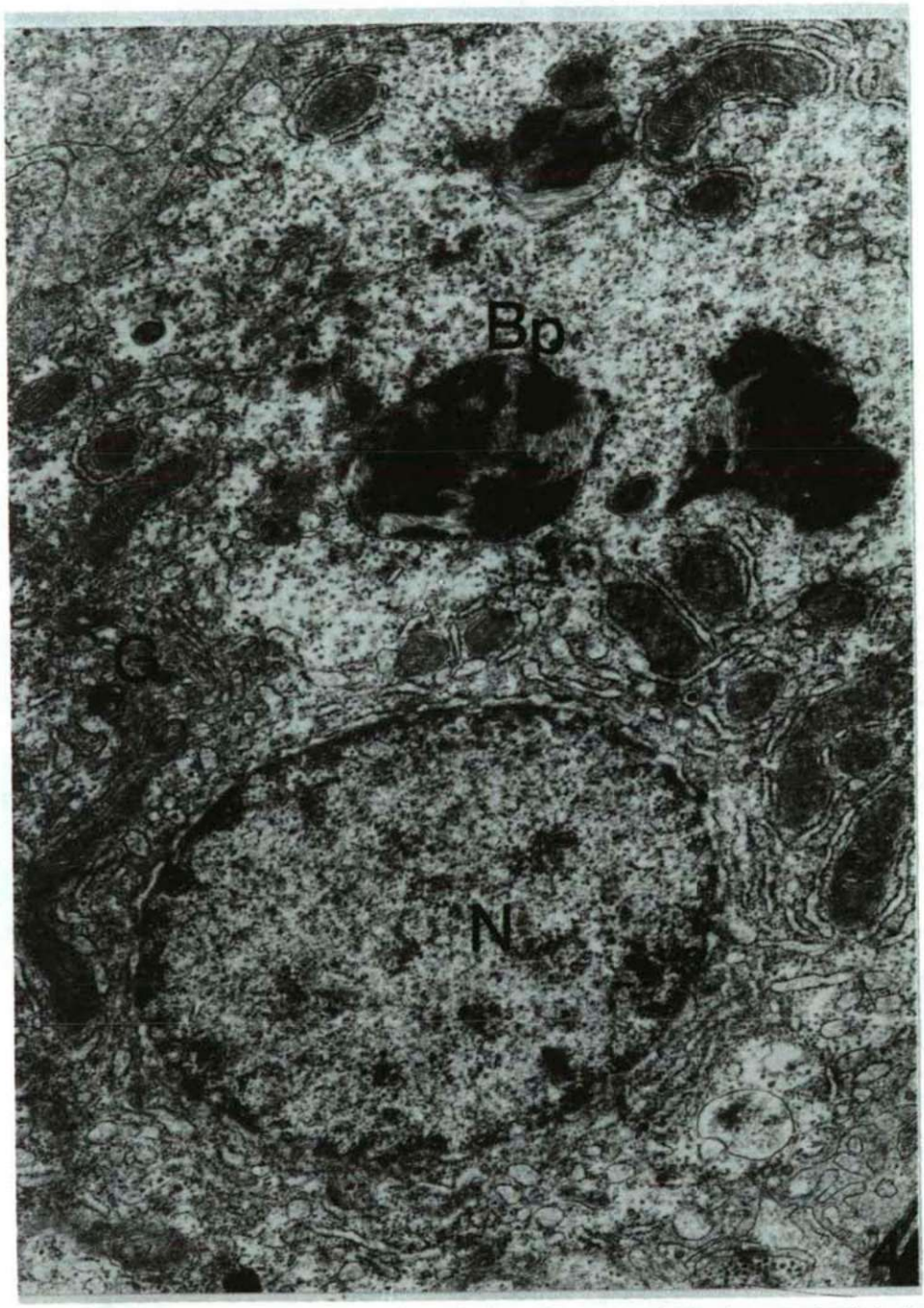

Fig. 4. Hepatocyte of paraquat-treated carp 14 days after treatment. Bile pigments of various size (Bp) have accumulated in the cytoplasm. N: nucleus; G: Golgi-apparatus.
x 18.000

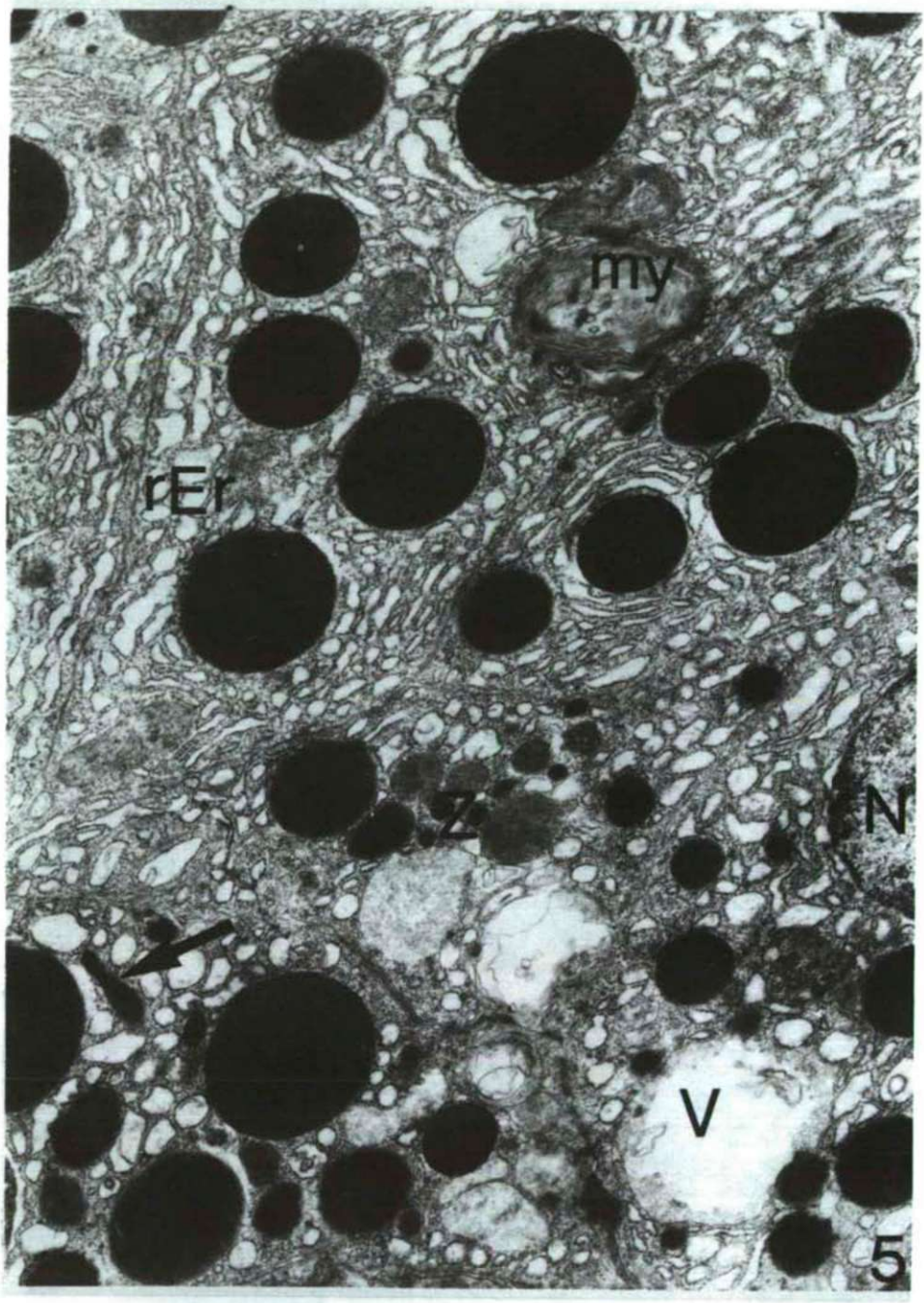

Fig. 5. Detail of exocrine pancreas in paraquat-treated carp. One part of the zymogen granules (z) have irregular shape and small size (arrow). The rough surfaced endoplasmic reticulum cavities are strongly dilated (rEr). Large, empty vacuoles (V) and myelin figures (my) are observable in the damaged cells. N: nucleus.
x 18.000

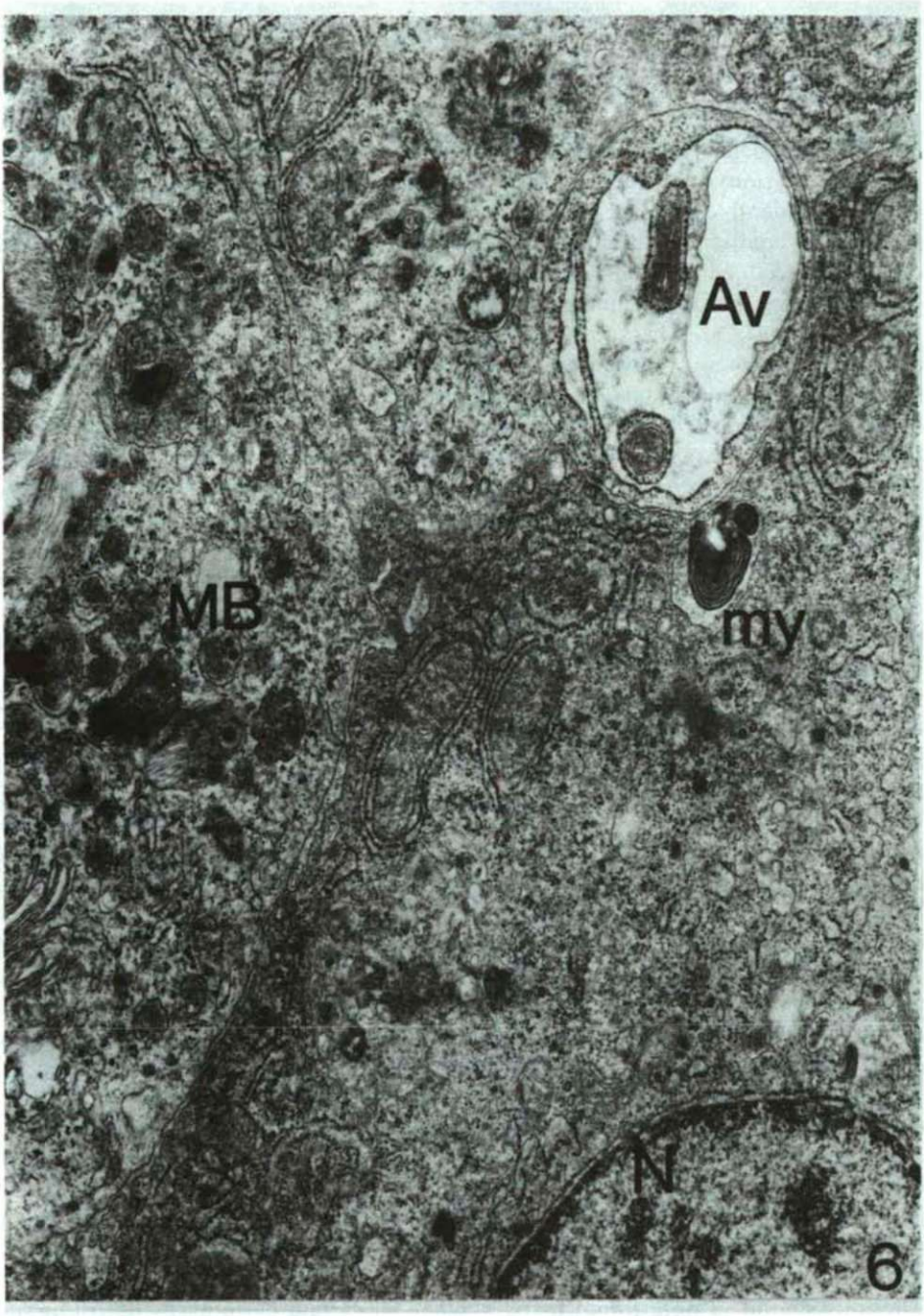

Fig. 6. Liver of carp treated with Ultracid 40 WP two weeks after treatment. The occurrence of large autophagic vacuole (Av) and numerous multivesicular bodies (MB) is characteristic of the hepatocytes. my: myelin figure; N: nucleus.
x 18.000

hepatocytes, too. Smaller-larger myelin figures, generally encapsulated in vacuoles, were observable in the Ultracid-treated hepatocytes. The number of multivesicular bodies — mainly in the neighbourhood of the Golgi-apparatuses — was strikingly high (Fig. 6). The electron density of certain vesicles was expressed in the multivesicular bodies very much.

In conformity with the condition subsequent to the paraquat treatment, there was a considerable increase in the number of bile pigments (Fig. 7). Mostly the filamentous components dominated in the inner substance of the bile pigments. The rough surfaced endoplasmic reticulum tubuli showed cisterna-like dilatation at places and fine granular, moderately electron dense material accumulated in their lumens (Figs. 7, 8). The substance in the rough surfaced endoplasmic reticulum cisternae occasionally showed regular arrangement. These are the so-called intracisternal paraprotein crystals which have probably accumulated as the consequence of the disturbed protein-transport (Fig. 8). In the neighbourhood of the rEr cisternae light mitochondria with swollen matrix could also be frequently observed. The majority of the mitochondria in the cytoplasm of the hepatocytes did not seem to be damaged and structural damage was not observed in the fine structure of the bile calaliculi either (Fig. 8).

Following copper sulphate treatment the previously described cytoplasmic alterations — thus e.g. increase in the amount of bile pigments, rEr-dilatation, mitochondrium swelling — were less expressed than in the case of the paraquat and Ultracid 40 WP. Nevertheless, the decreased electron density of the nuclei, as well as the appearance of myelin figures both in the karyoplasm and the cytoplasm could be regarded as new alterations. Lipid droplets were also detectable in higher amount in the hepatocytes after copper sulphate treatment than in the case of the previous two agents (Fig. 9).

KIDNEY: On the effect of paraquat-treatment the regular arrangement of the microvilli of the tubular epithelial cells disappeared, especially on the surface of the damaged cells (Fig. 10). Relatively intact cells also occurred besides the damaged tubular epithelial cells and focal, severely altered cells. The damaged cells were often of the „light" cell type, with strongly swollen mitochondria, picnotic nucleus, varying sized vacuoles and strongly electron dense, amorphus materialheaps were observable in their cytoplasm. Apart from mitochondrium-damages, a decrease in the amount of mitochondria was also manifested in the cytoplasm. Considerable cell damage could not be detected in the kidney glomeruli.

After treatment with Ultracid 40 WP, strikingly light nucleoli, poor in chromatin, were found in certain tubular epithelial cells (Fig. 11). A large number of phagolysosomes and myelin figures was observed in the cytoplasm. The presence of amorphus, electron dense material was observed in the phagolysosomes. There was a striking increase in the amount of the irregular shaped vacuoles, too, in the epithelial cells. The development of a part of the vacuoles was probably due to the fact that the ribosomes became detached from the cisternally dilated rEr-membranes. The mitrochondria were found to be swollen, in certain cases even the continuity of the outer membrane was found to be interrupted. The microvilli on the apical

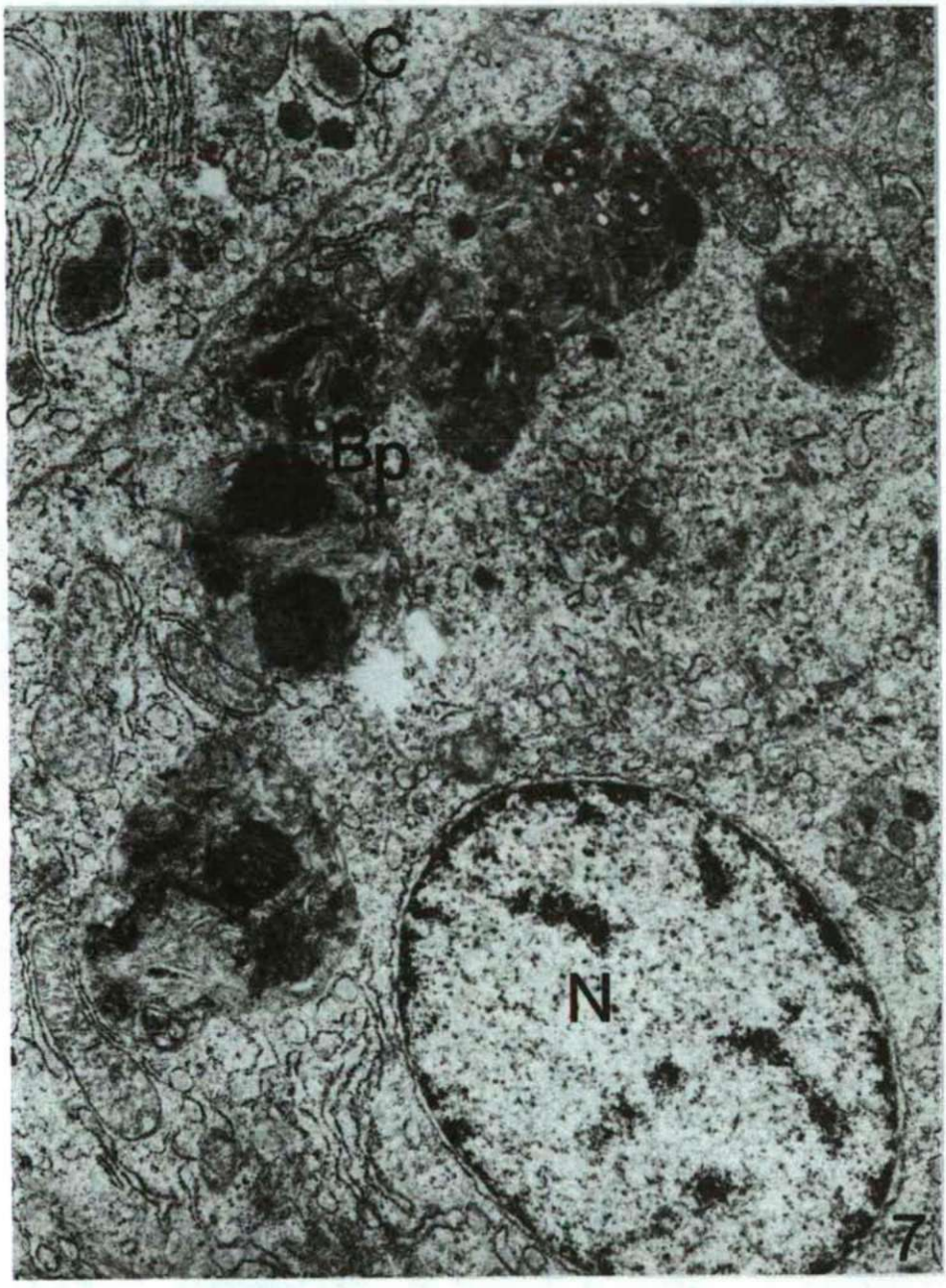

Fig. 7. The mass appearance of bile pigments (Bp) accompanied the Ultracid 40 WP treatment in the liver parenchyma cells, two weeks after treatment. N: nucleus; C: intracisternal accumulation of material.
x 18.000

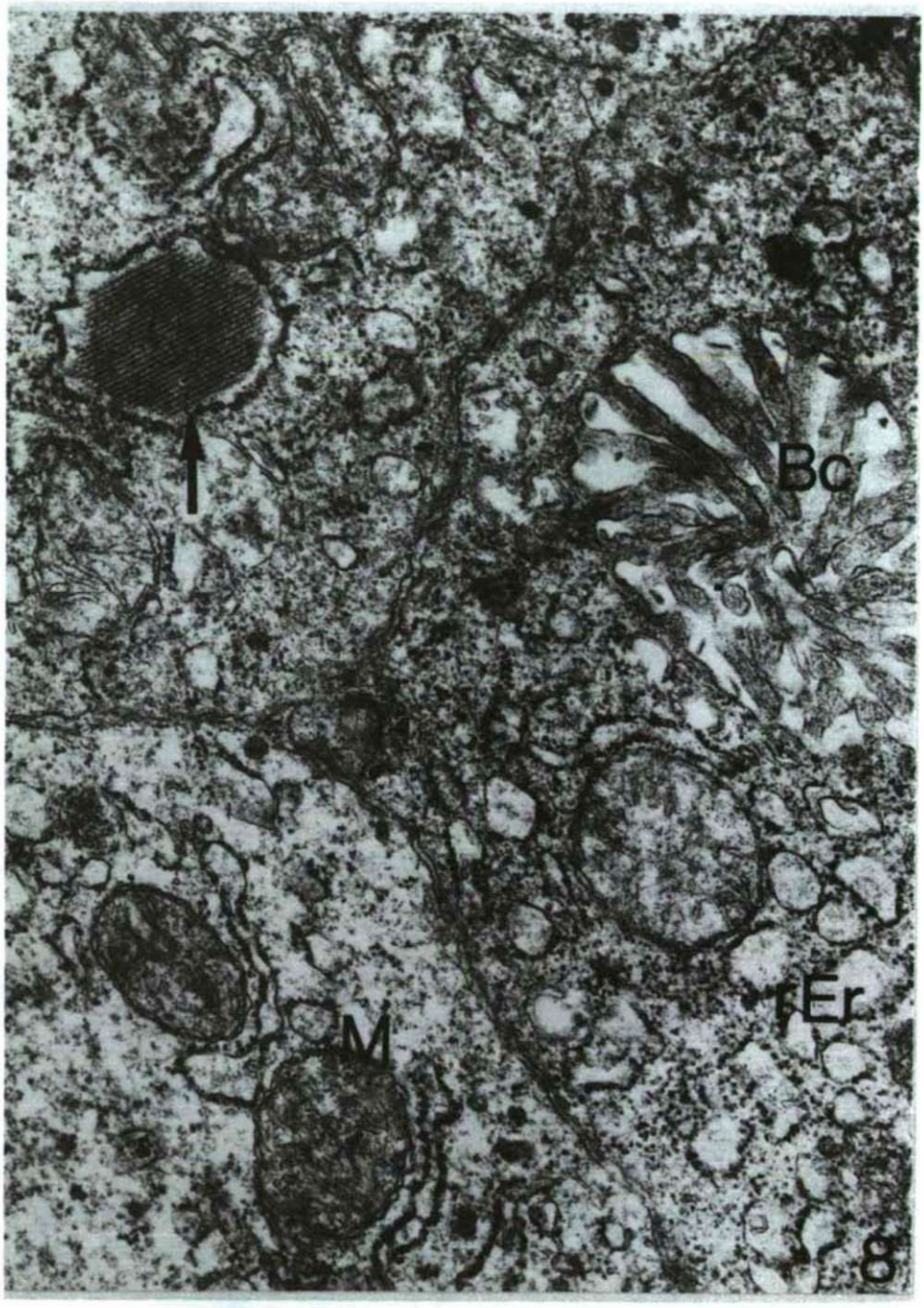

Fig. 8. Details of hepatocytes beside a bile canalicule (Bc). A paraprotein crystal showing parallel arrangement developed in the dilated rEr cisterna (arrow). M: mitochondrium
x 30.000

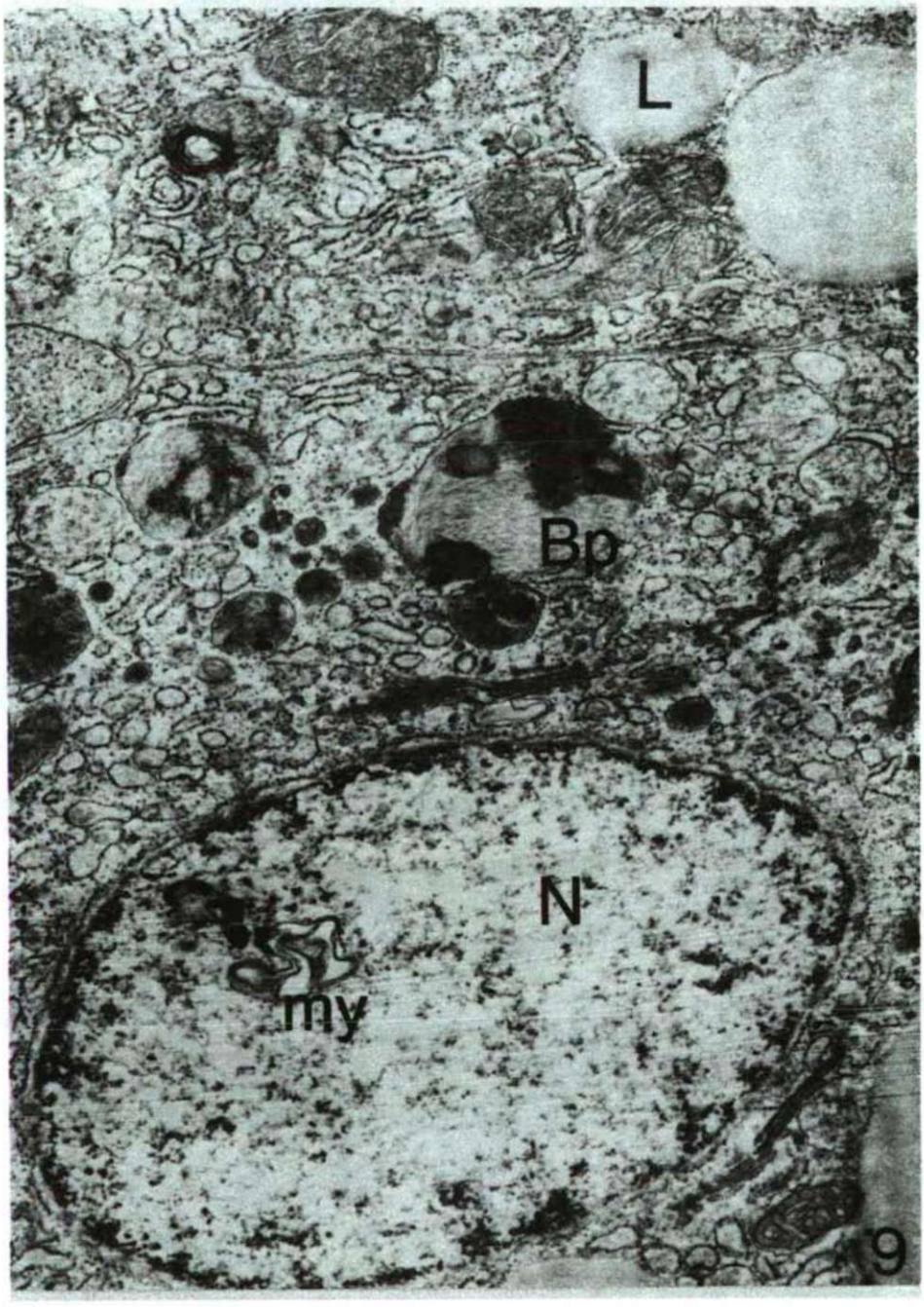

Fig. 9. Detail of carp hepatocyte 2 weeks after copper sulphate treatment. Myelin figures (my) appeared in the karyoplasm of the nucleus (N), poor in chromatin. Large lipid droplets (L) can be seen in the hepatocytes beside the bile pigments (Bp).
x 20.000

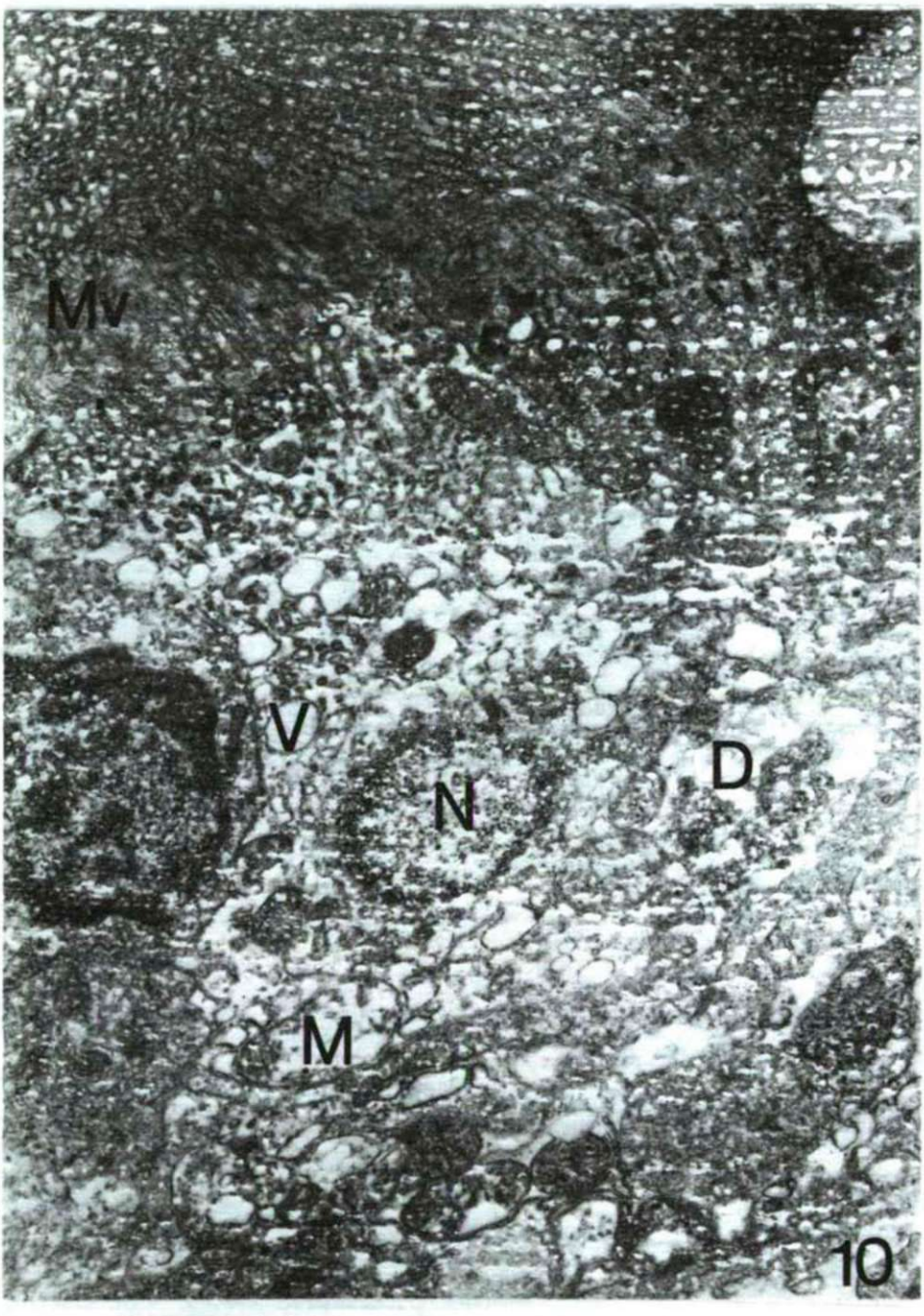

Fig. 10. Carp kidney, epithelial cells of primary convoluted renal tubule two weeks after paraquat treatment. The appearance of swollen mitochondria (M), vacuoles (V), cell detritus (D) are the signs of cell damage. The arrangement of the microvilli (Mv) has become disorganized. N: nucleus.
x 12.000

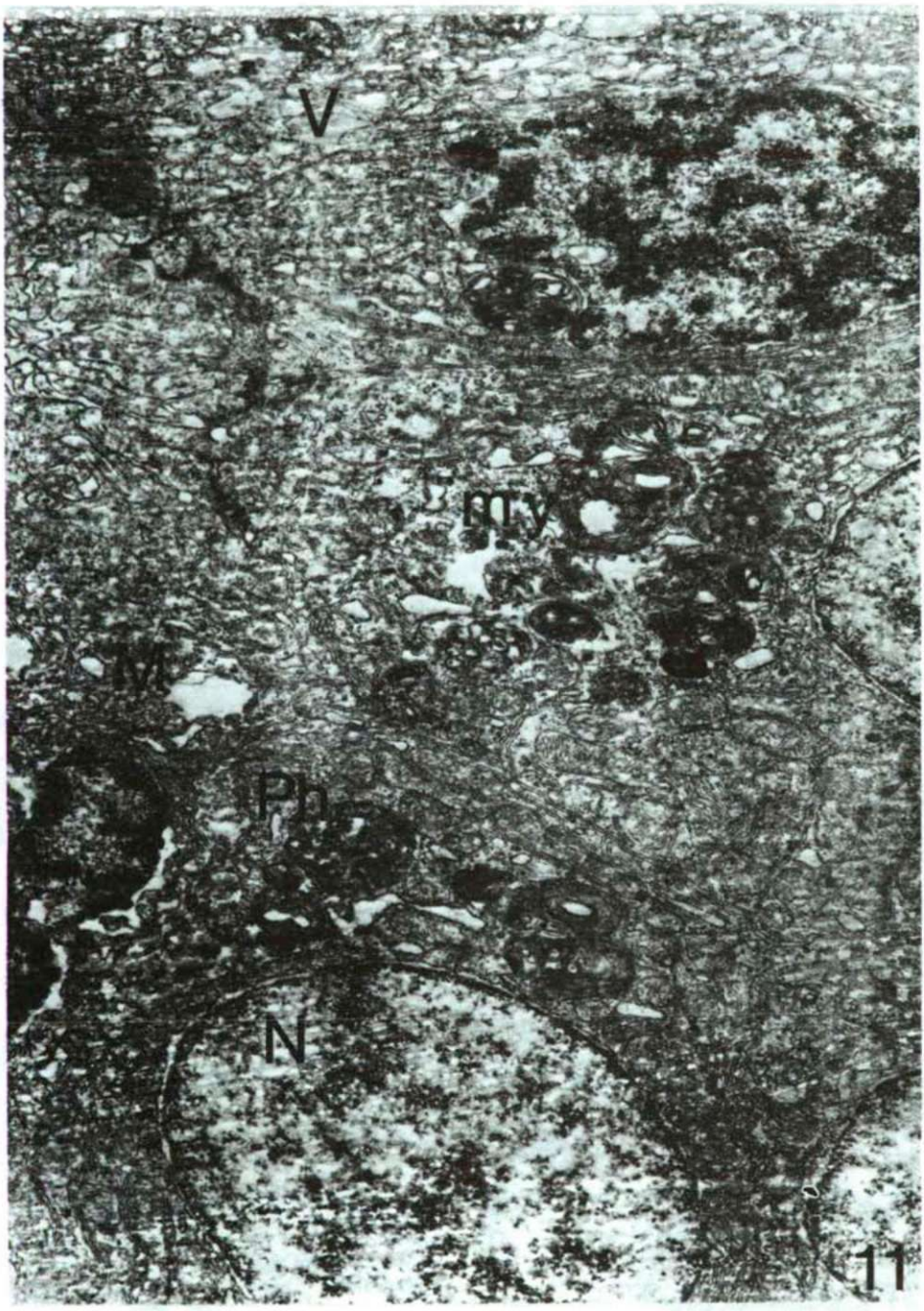

Fig. 11. Kidney of carp treated with Ultracid 40 WP, tubular epithelial ells. Chromatin-poor nucleus (N) and mass occurrence of myelin figures (my) is characteristic in certain cells. Ph: phagosome; V: vacuole; M: mitochondrium.
x 12.000

Fig. 12. **Kidney of carp treated with copper sulphate, 2 weeks after treatment.** Electron dense patches (Sp) are detectable in the clear substance of the nucleoli (Nu). Vacuoles (V) are frequent in the cytoplasm of the tubular epithelial cells, often in the neighbourhood of the damaged mitochondria (M). L: lipid droplet; my: myelin figure.
x 18.000

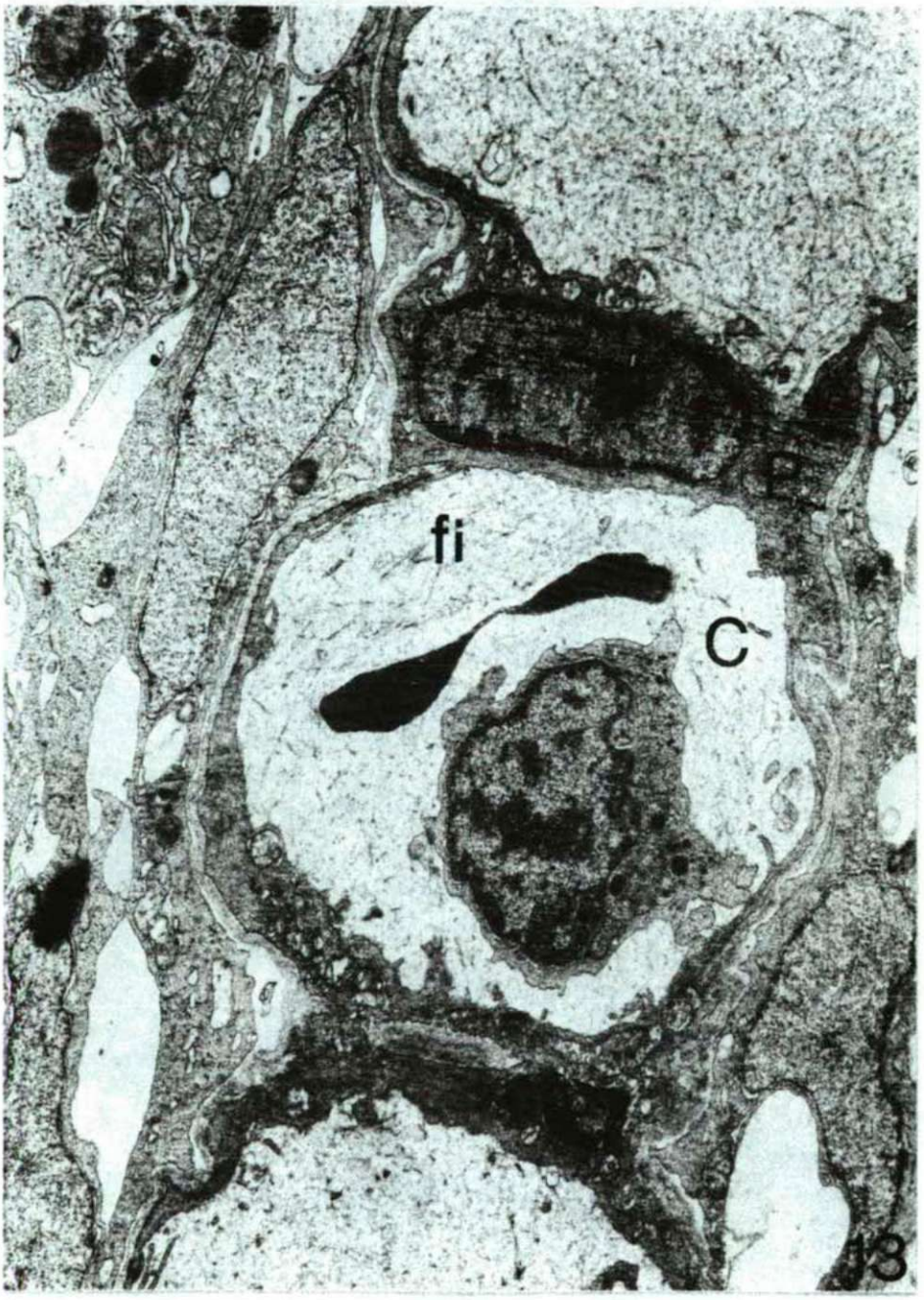

Fig. 13. Carp gill 2 weeks after paraquat treatment. Fine fibrous matter(fi) is observable in the lumen of the capillaries (C). P: pillar cell.
x 12.000

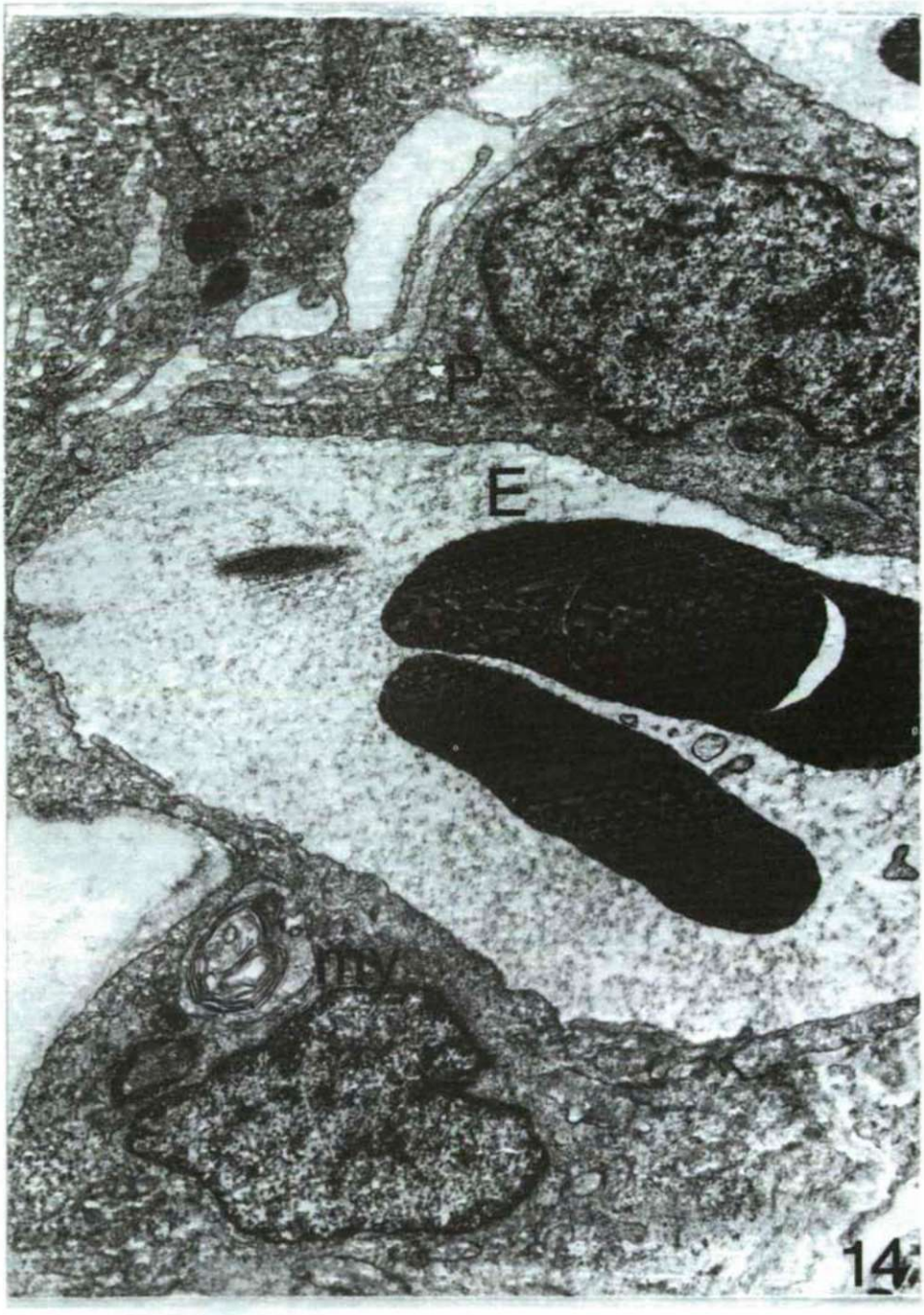

Fig. 14. Carp gill 2 weeks after Ultracid 40 WP treatment. Myelin figures (my) developed in the pillar cells (P). E: erythrocytes.
x 18.000

pole of the cells — similarly to the paraquat-treatment — lost their regular arrangement here, too. Contrary to the control, the presence of the electron dense endocytotic vesicles could hardly be observed on the apical pole of the tubular epithelial cells.

Following treatment with copper sulphate expansive cell damages were detectable in the renal tissue. Strikingly electron lucent nucleoli were found in the nuclei, in the matrix of which often electron dense patches (spotted nucleolus) appeared (Fig. 12). Large lipid droplets of varying density accumulated in the cytoplasm. The majority of the mitochondria were swollen, however, their crystae look relatively intact. Electron dense myelin figures were frequently detectable in the direct neighbourhood of the mitochondria. The presence of strikingly many, irregular vacuoles was also observable in the cytoplasm of the tubular epithelial cells. GILL: Following paraquat treatment, ultrastructural signs referring to cell damage could be observed neither in the pillar cells, nor in the respiratory epithelial cells, nevertheless, the accumulation of fine fibrous material was detectable in the capillary lumens (Fig. 13), which could be identified with fibrin on the basis of the ultrastructural characteristics.

Significant and expansive damage in the gill tissues was not caused by treatment with Ultracid 40 WP either, however, the occurrence of myelin figures was observed in the cytoplasm of certain pillar cells (Fig. 14).

The occurence of myelin figures was detected in small number following treatment with copper sulphate, too, mainly in the cytoplasm of the chloride cells.

Discussion

Taking the present tendency into consideration, the environment-polluting and -deleterious effect of the chemical agents used in industry and agriculture remains a great problem in respect to environmental protection. Since the physiological spectrum of effect of a single chemical agent is rather wide, the estimation of the effect as well as the determination of the mechanism of effect require complex study methods. In Hungary, however, only few attempts have been made so far for the complex detection of the harmful effects of the various pesticides exerted on fish (NEMCSÓK et al. 1981; BENEDECZKY et al. 1984). Following two hours of treatment with pesticide ROJIK et al. (1983) had observed severe cell damage in the liver, kidney and gill of carp. According to the results of the simultaneously performed biochemical studies (in conformity with the above observed cell damages) the serum transaminase enzyme activity had also shown a considerable increase. Even these acute experiments have given important evidence that pesticides reaching the water may produce severe damage to the vital organs of fish. Under natural circumstances, however, the pesticides firstly affect the fish organisms in low concentration, but durably (chronically), therefore the effect of low (sublethal) pesticide concentrations and longer (2 weeks) pesticide exposure was examined in our present studies.

According to expectations, serious and expansive cell — and tissue damages, resp., were not detected during the course of our present studies in the case of either

pesticide. The circumstance that after two weeks of paraquat treatment there were hardly any alterations referring to cell damage in the hepatocytes (only the amount of bile pigments increased) proves the strongly dose-dependent cell-damaging effect of the agent. Following application of double dose (10 mg/litre) Nemcsók et al. had experienced expansive and severe cell damage 2 hours after treatment (NEMCSÓK and BOROSS, 1982; ROJIK et al. 1983). The fact, however, that focal cell necrosis was experienced in the pancreas located in the direct neighbourhood of the liver, furthermore, expansive cell-organelle damage to certain cells, points out that the tissues of certain organs are more sensitive to the chemical impacts. Such organs as the liver, where the detoxication of various chemical agents takes place and for which the „drug metabolising" enzyme (or enzyme system) is given, are capable of preserving their structural and functional integrity (SIMON et al. 1983; 1984), other organs, thus the above-mentioned pancreas, become significantly damaged by the same dose. This fact is noteworthy as the frequent and severe damage of the pancreas has been well-known for a long time from the fish-breeding practice, which may be caused by a number of external factors — infection, intoxication (SCHÄPERCLAUS, 1954). The damaging effect of the various pesticides exerted on the same target organ can be rather divergent. The paraquat did not produce considerable alteration in the hepatocytes, at the same time the Ultracid 40 WP resulted a whole series of cell damages (increase in bile pigment, the appearance of a large number of myelin figures and autophage vacuoles, rEr dilatation, etc.). The paraprotein crystals appearing in the dilated rEr cisternae refer to the disturbance in the transport-process of the transportable proteins. This assumption is also supported by the circumstance that the damaged mitochondria were the most common next to the rEr cisternae. The development of the paraprotein crystals may be the consequence of the mitochondrial damages: if there is a lack of sufficient energy the rEr-transport becomes hindered, the proteins accumulate in the lumen of the cisternae. Similar phenomenon was observed in Dikonirt-treated liver tissues as well (BENEDECZKY et al. 1984). Neither the paraquat, nor the Ultracid treatment caused alterations in the nucleus of the hepatocytes. The copper sulphate treatment, however, resulted in the development of chromatin-poor nuclei, and even led to the formation of myelin figures in certain nuclei. It is noteworthy that the damage of the karyoplasm was not accompanied by the simultaneous and severe damage to the cytoplasmatic cell organelles, as observed in the case of Ultracid. Therefore, that the primary target of copper sulphate may be the nucleus. ROJIK et al. (1983) detected a considerable decrease in the chromatin substance as early as two hours following a 10 mg/litre concentration of copper sulphate. In our present experiments not a single animal survived the 10 mg/litre concentration of copper sulphate, therefore the pesticide concentration had to be reduced to one half. The mechanism by which copper sulphate brings forth a decrease in the chromatin substance cannot be answered without biochemical studies. The copper can be assumed to incorporate into the chromatin substance, through the supplantation of the Mg^{2+} inhibiting in such way the well-known condensation of heterochromatin in the karyoplasm.

The degenerative alterations were found to be more serious in the pancreas

than in the liver. The accumulation of the detritus representing focal cell necrosis points to lipid peroxidation (BLOCK, 1979), the membrane-damaging effect of which probably caused the complete decomposition of certain cells. This is also supported by the appearance of the large myelin figures, which are well-known to be products of decomposition (DE DUVE and WATTEAUX, 1966). The cisternal dilatation and sporadical degranulation of the rough surfaced endoplasmic reticulum tubuli prove that the protein-synthetizing system in the pancreas exocrine cells was damaged by the paraquat treatment. It is known that the longitudinal arrangement of the rEr tubuli is often discontinued in the case of insufficient energy supply (SCHAFF and LAPIS, 1979). Paraquat is known to be capable of the disjunction of the mitochondrial electrontransfer (OGATA and HASEGAWA, 1978). This agent seems to exert its damaging effect on the elements of the protein-synthetizing system (rEr) through the mitochondrial system in this case, too.

The focal cell necrosis observed in the pancreas did not develop in the renal tissues even following pesticide treatment either. From the three agents, only the copper sulphate and the Ultracid caused damage to the nucleus, the paraquat did not. Apart from the damage of the chromatin substance the appearance of spotted nucleoli is noteworthy, referring to the damage of the RNA–metabolism according to several authors (LAPIS and BENEDECZKY, 1966; STENRAM, 1969; KOPPER et al. 1969). All three agents produced the same cytoplasmic damages (swelling of the mitochondrium, appearance of myelin figures, lipid droplets, vacuoles and cell detritus), as they were observed in the liver tissues. „Kidney-specific" ultrastructural alterations could not be detected. This partly relates to the facts that the kidney glomeruli did not show pathomorphological alterations, and that as a parenchymatic tissue, the resorption epithelium of the convoluted renal tubules reacts to the external effects in many respects in similar way as also parenchymal liver tissue itself. Cell damage appearing expansively furnished unambiguous proofs that in the given sublethal dose all three agents induced pathological alterations in the renal tissue. The alterations in the glomeruli were not definite and were only of focal character in the epithelium of the convoluted renal tubules, too. Their significance can be summed up in that both the function and structure of a vital organ can be damaged even after a relatively short exposure time (2 weeks), which may lead to irreversible pathological alterations in the case of unfavourable external conditions (e.g. anoxia, high water temperature, infection, etc.).

It is striking that the slightest ultrastuctural alterations were experienced in the gill tissue (though this tissue is in the most direct contact with the harmful agents). Apart from the rare appearance of the myelin figures, fibrin filaments were observable as well in the capillary lumens following paraquat-treatment. In respect to the relative lack of the cytopathological alterations there are two concepcions:

1. The paraquat is depleted from the gill tissue quickly, and so it does not cause cell damage to a significant degree.
2. There may have been pathological alterations in the early stage of the treatment (see ROJIK et al. 1983), but the cells became regenerated by the end of the two weeks' treatment period.

Since the biochemical measurements of NEMCSÓK (1983) manifested the maximal transaminase and LDH activity values after the first week, and then these values gradually decreased, it is presumable that the tissue of the gill — due to its great ability of regeneration — had already restituted the transitional cell damages; therefore ultrastructural signs referring to cell damage could only sporadically be found at the end of the 2 weeks' treatment.

Summarizing our results we can conclude that with the help of the electron microscopic cytopathological method early cellular and subcellular alterations can be detected in the carp liver, kidney and gill tissues produced by the sublethal concentrations of pesticides and insecticides. Our observations supply important data for the agricultural practice and the veterinary organizations in view of both the prevention of the catastrophic perish of fish as well as the control of the chemical pollution of our water.

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CELL TYPES OF THE ENTERIC NERVE PLEXUSES IN THE CHICKEN (*GALLUS DOMESTICUS* L.)

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Abstract

The innervation of the esophagus and small intestine was studied with impregnation method. The myenteric plexus located between the concentric and longitudinal smooth muscle layer of the tunica muscularis was found to be well developed and of reticular arrangement in both enteric regions. The Meissner plexus in the tunica submucosa was particularly poor in cells and fibers in the esophagus.

On the basis of affinity to silver salts the neurons of the enteric nerve plexuses could be argentophilic and argentophobic. Both cell types occurred in the small intestinal plexuses, mainly argentophile cells could be found in the esophagus.

On the basis of the cell processes, uni-, bi- and multipolar cells were found in the plexuses. Besides the known Dogiel-types, a new neuron-type was also described among the multipolar neurons.

On the basis of cell-volume values, small and large cells were observable in the small intestinal plexuses, while only small cells were manifested in the esophagus. The volume of the small cells could be ranked till 1600 μm^3, the large cells could be ranked among the domain above 1600 μm^3 volume value.

Key words: chicken, enteric nerve plexus, neuron types, cell volume

Introduction

Numerous data are at disposal regarding the location, structure and junctions of the nerve plexuses found in the intestinal tract of the vertebrates (Christensen et al. 1983; Furness and Costa, 1980; Gunn, 1959; Kolossow et al. 1932.) However, the types of the neurons having role in the nerve plexuses have not been defined unambiguously.

Dogiel (1896; 1899) was the first to classify the cells of these plexuses on the basis of the number and lenght of their processes. Accordingly, Dogiel I., Dogiel II. and Dogiel III. cell types are known. Later on, others also confirmed this type of classification of the intestinal neurons (Hill, 1927; Kolossow et al. 1932; Stach, 1973; 1982a).

Other classifications of the neurons of the enteric nerve plexuses are also known; thus on the basis of affinity to silver salts argentophile and argentophobe neurons can be differentiated. Attempts were made to find correlation between the argentophile and argentophobe cells and the Dogiel cell-types by Honjin et al. (1959) as well as Rintoul (1959) in the case of mammals, and by Michail and Karamandlidis (1967) in the case of birds. The plasma of Dogiel I. type neurons stains lighter than that of the Dogiel II. type ones, but their nuclei stain rather dark.

In the case of chickens, MICHAIL and KARAMANDLIDIS (1967) found the incidence rate of the argentophile and argentophobe cells to be 1:1.

The classification of neurons following silver salts staining is rather difficult since staining is influenced by many factors. Several authors have studied the relationship between the degree of silver affinity and the cholinesterase activity of the neurons (BENNETT, 1969; GUNN, 1968; LEAMING and CAUNA, 1961). On the basis of their studies these authors determined that the argentophile cells show negative, while the argentophobe cells show positive cholinesterase activity. It is known from the work of BENNETT (1969) that the Dogiel I. type cells have strongly positive cholinesterase activity, while the Dogiel II. types show weak cholinesterase activity.

Several authors have classified the neurons of the plexuses on the basis of their size and $AgNO_3$ staining (FEHÉR and VAJDA, 1972; GABELLA and TRIGG, 1984; GUNN, 1959; 1968; HONJIN et al. 1959). These authors have reported on the comparative data regarding the neurons of either the various gut sections of one species or the same gut sections of various species (mostly mammals).

Only few systematic comparative studies by quantitative morphological methods are at our disposal regarding intestinal innervation, and even these mainly pertain to mammals.

The aim of the present study was to classify the neurons of the enteric nerve plexuses found in two sections of the basis of comparative morphological and morphometric data.

Material and method

Studies were performed on the esophageal and small intestinal (with the exception of the duodenum) segments of young, 3–4 weeks old (of 35–40 g weight) roosters. The nerve plexuses of the intestinal tract were examined on sections stained with BIELSCHOWSKY–GROS–CAUNA impregnation of 15–20 μm. (The sections were prepared parallel with the longitudinal axis of the intestinal tract). The diameters of the cells perpendicular to each other were studied by ocular micrometer besides 2000x magnification. Only those cells were measured in which the nuclei were observable. The calculations from the measured data (volume and excentricity values) were done according to PALKOVITS (1962; 1968). 600–600 cells were measured from each plexus.

Results

The myenteric plexus was situated in the connective tissue separating the tunica muscularis layers of the intestinal tract. It was characteristic of its structure that neuron groups were located at the branchings of the large nerve fiber bundles, which could even stand of 10–15 cells in the esophagus, and of 30–35 in the small intestine (Plate I., figs. 1,2,3). The thick bundles became all thinner by means of gradual branchings. Ganglia containing few number of small cells could sometimes be seen along the smaller bundles as well. This latter one was more characteristic to the esophagus.

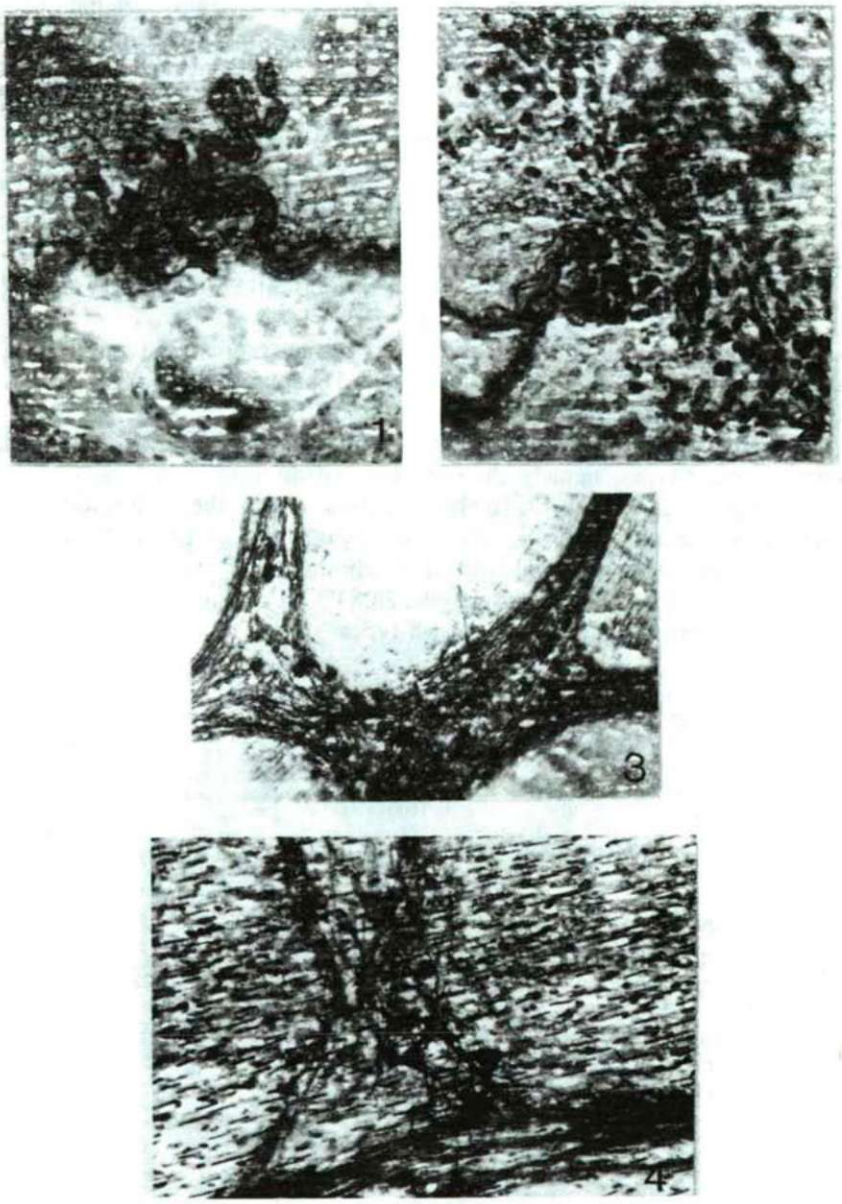

Plate I: figs. 1. and 2.: Detail from the esophageal myenteric plexus. 930x.
figs. 3. and 4.: Ganglia of the small intestinal myenteric plexus. 350x.

Following $AgNO_3$ impregnation the neurons of the plexus were light (argentophobic) or dark (argentophilic). The dark cell type was observable in the esophagus; in the small intestine both types of cells were found in equal number (Plate I., fig. 4.).

The cells could be grouped on the basis of their calculated volume and excentricity values (Plate II). Accordingly, the cells of the small intestinal myenteric plexus could be grouped into two; namely into the small and large cell groups. Small cells were ranked which had volumes till 1600 μm^3; 59, 16% of the measured cells were mostly round, or had strongly elongated elliptic form.

The other group consisted of the large cells amounting to 40.84%, their volume being above 1600 μm^3 (1600–15000 μm^3).

The cells of the myenteric plexus of the esophagus represented a uniform group. These neurons had sizes identical with the first, i.e. small cells of the small intestine on the basis of their size domain.

The number of the neuronal processes also varied. Among the measured cells all morphological types, namely the uni-, bi- and multipolar cells were detectable (Plate III., figs. 1, 2, 3. and 4.). In the myenteric plexus the multipolar cells were the highest in amount, being 88.33% in the esophagus, and 91.82% in the small intestine. One part of these could be ranked among one of the known Dogiel-types, their other part (19.16% in the esophagus, 28.83% in the small intestine), however, could not be compared with either known types.

		Volume		Eccentricity	
		50–1600 u^3 small cells	1600–15000 u^3 large cells	small cells	large cells
small intestine	myenteric plexus	+	+	1:1.0 1:1.5	1:1.0 1:1.2 1:1.4
	submucous plexus	+	+	1:1.0 1:1.2 1:1.3 1:1.5	1:1.0 1:1.2 1:1.3
esophagus	myenteric plexus	+	–	1:1.0 1:1.5	–
	submucous plexus	+	–	1:1.0 1:1.2	–

Plate II: Grouping of the enteric nerve plexus neurons according to volume and excentricity values.

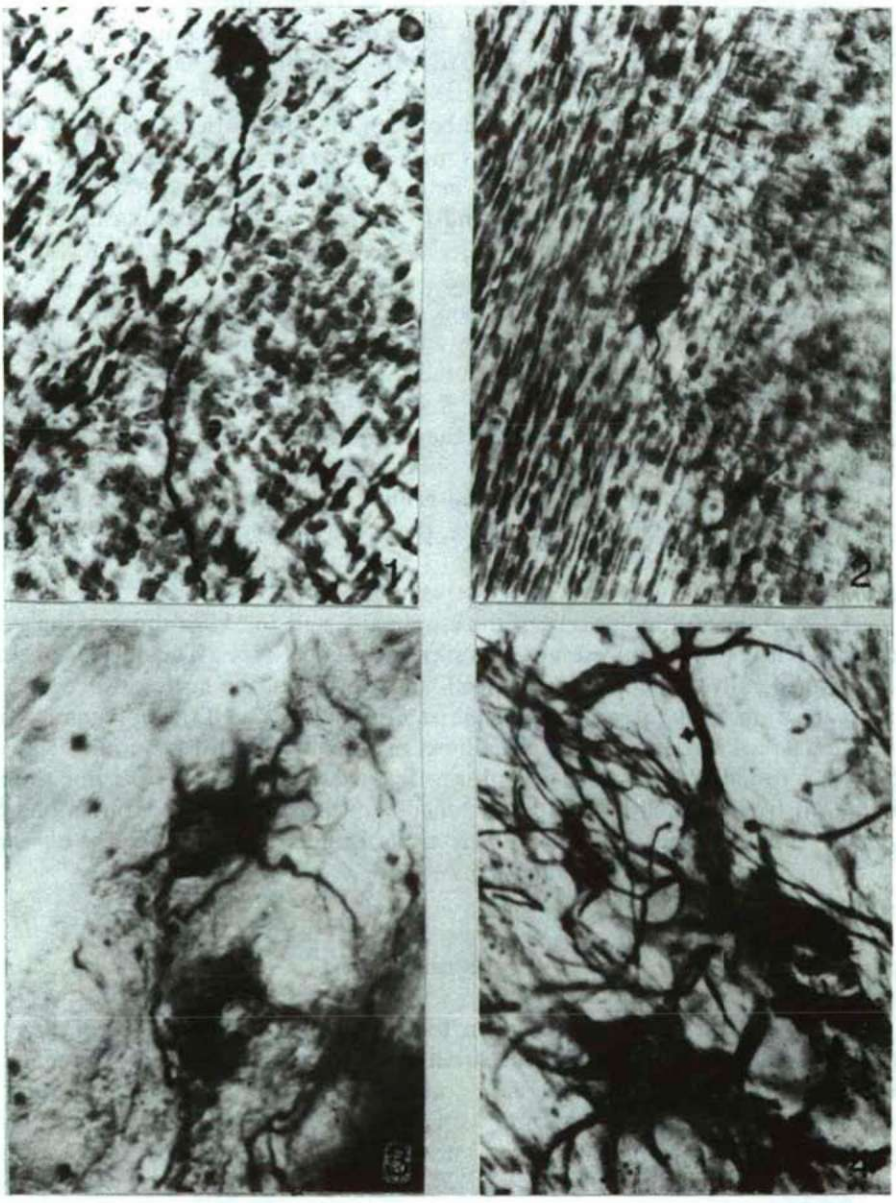

Plate III: figs. 1,2,3. and 4.: Cell types from the small intestinal myenteric plexus. 570x.

From the cell processes only a few could be traced within the ganglia, mainly belonging to the light-staining cells; while those of the darkly staining cells generally left the ganglia, either proceeding towards the neighbouring ganglia, or in most cases towards the inner concentric muscle layer.

The submucous plexus was situated between the concentric muscle layer of the intestinal tract and the tunica muscularis mucosae. Its nerve fiber bundles were thin, containing only a few fibers, and rather small ganglia made up of a few cells. It was characteristic that single cells were found to occur sporadically along the bundles (Plate IV., figs. 1, 2). Single fibers were also detectable besides the small bundles, in general proceeding together with blood vessels.

The Meissner plexus of the esophagus was found to be poor in cells compared to other sections of the intestinal tract, and these few cells were also difficult to stain, thus only 200 cells could be measured from this plexus.

Similarly to the myenteric plexus, the cells of the small intestinal Meissner plexus belonged to two groups; those of the esophagus to one group, all being small cells (Plate II).

The percental distribution of the cell groups in the small intestinal plexus was as follows: the first (small cells) was 37%, the second (large cells) was 63%.

The majority of the cells of the plexus were multipolar here, too (80% in the esophagus, 90.32% in the small intestine) (Plate IV., figs. 3, 4).

25.5% of the multipolar cells of the esophagus, and 38.5% of those of the small intestine could not be grouped into either known Dogiel-types. The nucleus of these cells was generally excentric, thus the cell had pear-form, the nucleus was rarely of central location, and the cell was roundish. Following $AgNO_3$ impregnation the cells stained dark. 4–5, sometimes even more, maximally 10 processes could originate from the cell body. These were of uniform thickness and gradually became thinner moving off from the cell body. It was difficult to differentiate the axon among the processes (Plate IV., figs.3, 4). These were either isolated cells, or could be observed in a rather small ganglia containing few cells.

Discussion

The myenteric plexus is located in the connective tissue layer separating the tunica muscularis layers of the intestinal tract, the inner concentric and outer longitudinal smooth muscles. The developmental stage of the two layers is different in birds (FARNER, 1960; MAGON and MOHAN, 1976). In chickens the inner muscle layer is more developed in the studied intestinal sections.

Reticular arrangement is characteristic to the myenteric plexus, which is very similar to the observations in mammals (CHRISTENSEN et al. 1983; FEHÉR and VAJDA, 1972; HILL, 1972; SCHOFIELD, 1968). The primary thick nerve fiber bundles are the basis of the network-structure, found in the complete lenght of the plexus. These are connected by thinner, secondary bundles. The smaller-larger ganglia are situated at the branchings of these two kinds of bundle systems. Single fibers are rare in the

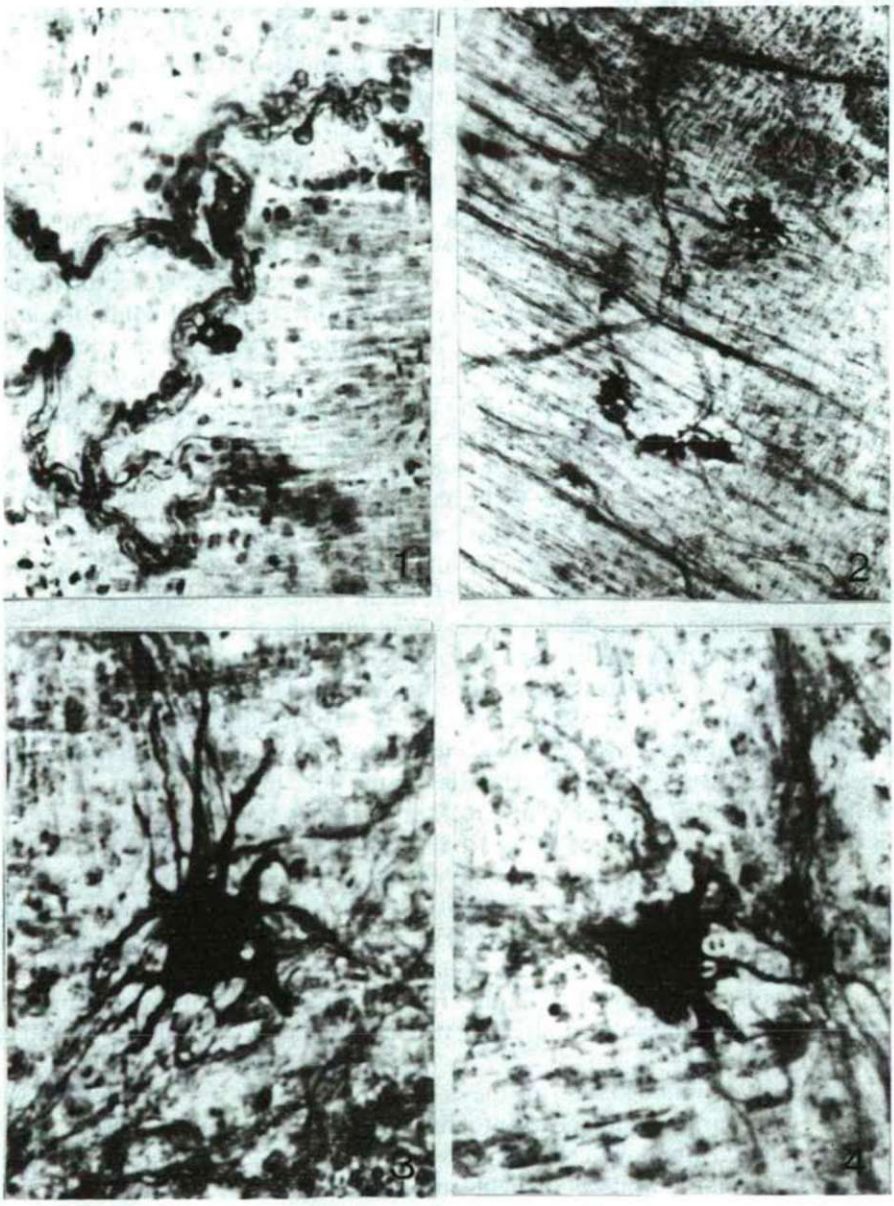

Plate IV: fig. 1.: Detail from the esophageal Meissner plexus.800x.
fig. 2.: Solitary cells of the small intestinal Meissner plexus. 330x.
fig. 3.: and 4.: Characteristic cells of the enteric nerve plexuses. 750x.

myenteric plexus, these are mostly characteristic to the enteric nerve plexuses of mammals.

The submucous plexus is mainly built up of single nerve fibers and bundles containing low number of nerve fibers. Its neurons can be observed singly along the nerve fibers or as few cells (2–3) forming ganglia. The Meissner plexus of the chicken esophagus is particularly poor in neurons and nerve fibers, and the neurons stain weakly (KOLOSSOW et al. 1932).

Comparing the nerve plexuses of the chicken gut with those of the mammals significant deviations can be detected: In mammals the submucous plexus is rich in neurons, these are generally arranged in the form of ganglia. The occurrence of single cells is not characteristic. The nerve bundles are thick and contain a lot of nerve fibers. The neurons and nerve fiber bundles show reticular arrangement, and thus the Meissner plexus of the mammalian intestine can be compared with the arrangement of the myenteric plexus. The Meissner plexus of chicken is morphologically similar to the enteric nerve plexuses of the fishes (BURNSTOCK, 1959) and amphibia (GUNN, 1951), where there are also only few nerve fibers and cells detectable and in the arrangement of which the reticular structure is less recognizable.

In the chicken enteric nerve plexuses small and large cells can be differentiated according to the calculated cell volume values. The regional distribution of these is uneven, since only small cells are observable in the esophageal nerve plexuses, while cells of both volume can be found in the small intestinal plexuses. Similar studies have been performed in the case of species belonging to other vertebrate groups, too, thus in the case of fishes (BURNSTOCK, 1959), and mammals (FEHÉR and VAJDA, 1972; GABELLA and TRIGG, 1984; GUNN, 1968). The results obtained by us can better be compared with those of FEHÉR and VAJDA (1972), on the one hand, because the measurements were performed according to the same method, on the other hand, because the individual number of the measured groups was also identical. On the basis of their calculated volume values, the measured cells were grouped in a similar way however the size domain of the different groups was much smaller in the case of chickens compared to mammals. For chickens the maximal volume of the so-called small cells was 1600 μm^3, this being 15000 μm^3 for cats. From the neurons of the chicken enteric nerve plexus the large neurons can be regarded as the cells having volume values between 1600–15000 μm^3. In the case of mammals even the volume of the medium neurons is much greater, reaching the value of 30000 μm^3 and the large cells 6000 μm^3.

The degree of impregnation of the cells can be brought into connection with their sizes. The darkly staining argentophile cells may be small and large, at the same time the argentophobe cells are only large. In the esophageal plexuses every small cell stains dark, while both light and dark cells can be found in the small intestine. No measurements were performed in respect to the quantitative occurrence of the argentophile and argentophobe cells, nevertheless, relating numerical data are at disposal in the work of MICHAIL and KARAMANDLIDIS (1967), who had found the ratio of the two cell types to be 1:1 in chicken small intestine.

Especially the darkly impregnated cells could be grouped according to the number of their processes. Thus, uni-, bi- and multipolar cells could be differentiated (SCHOFIELD, 1968).The majority of the multipolar cells could be ranked among the known Dogiel cell types. One further type could also be differentiated. These cells are similar to the Stach type IV. cells on the basis of their shape, and to the Dogiel I. type cells regarding the amount of their processes (DOGIEL, 1896; 1899; STACH, 1982b).

Several authors (KÖLLIKER, 1984; KUNTZ, 1922; SCHOFIELD, 1968) do not agree with the known Dogiel kind of classification, according to which the cells type I. are motoric, the type II. are sensory and the type III. are interneuronal cells. These authors dispute the justification of this rigid classification, on the basis of the transitional types. No doubt, the neuron classification entirely on the basis of morphological methods has no longer meets the modern neurobiological requirements, and the characterization of the cells should be supplemented by immuncytochemical and neurophysiological data.

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THE ROLE OF THE FLOOD AREA AND SLOPES OF DAM OF THE RIVER TISZA IN FEEDING WILD BEES

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Abstract

In the spring aspect the foster-plant spectrum is provided by the species of the *Potentilla genus* plant family at the flood areas, and by the species of the *Labiatae*, *Papilionaceae* and *Cruciferae* plant families at the slopes of the dam.

In summer the most significant pollen- and nectar-producing plants in Hungary are the species of the *Cruciferae*, *Boraginaceae*, *Papilionaceae*, *Compositae* and *Lythraceae* plant families.

In autumn the nectar-production gradually ceases and the amount of pollens decraeses.

At the areas examined by us the flowery meadow-plant and weed species-combination is the most varied in the biotopes of the Upper-Tisza. The nectar- and pollen-production at the area is significantly supplied by the resowing of the papilionaceous agrocultures.

On the basis of our studies the nectar-production of the *Symphytum officinale*, *Salvia nemorosa* and the *Echium vulgare* is the most important from wild apicultural point of view.

The bee pasture-land of the flood area and the slope of the dam is more significant for the wild bees than from the viewpoint of the honey-bees.

Key words: Tisza–embankment, flood area, nectar, wild bees.

Introduction

The significance of the nature-close plant-associations has increased with the repression of the ruderal areas from the viewpoint of the feeding, nesting and brood-tendance of the wild bees. Through their flowering plants, the flood area and dam-system — generally not exposed to anthropogenic effects with the exception of mowing — ensure continuous pollen- and nectar-source for the wild bee populations. As pasture-land this area is perhaps more important for the wild bees, than from apicultural point of view. The dam sides of the rivers are practically exempt from the use of chemicals, thus they have resulted the enrichment of the economically also significant, entogamic wild bee species. The agricultural significance of these wild bees in our country has been studied in detail at various regions of Hungary by BÖJTÖS (1956), BENEDEK (1977), BENEDEK et al. (1971, 1973, 1975, 1977) and TANÁCS (1974, 1977), through the pioneer works of L. MÓCZÁR (1956, 1959a, 1959b, 1961a, 1961b). The flower-structure of several meadow-, weed and crop plants hinders autogamy in our country, too (KNUTH, 1899, TROLL, 1967, FREE, 1970). Thus, the role of wild bees in the entogamic pollination of the plants is

essential. This is especially important in the case of the wild bee populations swarming from the flood area and slope of dam — as bee pasture-lands — to the atrocultures of the back areas.

Besides the entomological researches, one of the aims of our investigations was to determine the meadow-plant and weed species-spectrum serving as energy source for the wild bee populations in the given terrestrial ecosystem, and further, to estimate the production of the more significant plant species producing nectar and pollen.

Study areas, material and methods

The study areas were the relatively nature-close grasslands of the flood area and slope of dam on the water- and protected sides of the dam-system at the Hungarian section of the Tisza river between Tiszasziget and Tarpa (165 and 712 riv.km). Alongside the 586,4 km long section of the river the area of the water-side slope of dam and the flood area was 83515 ha, from which 19873 ha, 24% was forest, 6350 ha, 8% was orchard, 57292 ha, 68% was plough land, pasture and meadow (BIRÓ, 1984). The slope of dam on the protected side and the back areas not exposed directly to angroculture were 4350 ha large. The studied section was divided into 3 subareas: Lower-Tisza (L-T), Middle-Tisza (M-T) and Upper-Tisza (U-T) which will be mentioned hereinafter in abbreviated forms.

The surveying sites of the L-T. terrestrial ecosystem were Tiszasziget, Szeged, Körtvélyes-Mártély, Körtvélyes-sziget, Szandaszőlős, Röszke, Algyő, Csongrád, Csongrád-Bokros, Alpári-meadow, Lakitelek-Tőserdő. A total of 113 recordings were performed.

The surveying-sites at the M-T. were Kisköre, Tiszanána, Sarud, Poroszló, Tiszavalk, Abádszalók, Tiszaderzs, Tiszaszőlős, Tiszafüred-Tiszaörvény, Tiszacsege. The number of study days was 41.

The surveying-sites at the U-T. were divided into zones. Tokaj 1. zone: area directly in front of the settlement, the species-combination of the phytocenosis here differed in some respects from the species-composition of the plant-association formed at the dams. Tokaj 2. zone: this area was at a distance of 2 km south of Tokaj. Further surveying-sites at the U-T. were Jánd, Gulács, Tivadar and Tarpa. The number of study days was 37.

The total number of study days was 191 at the three dam-sections, but amounted to 203 together with recordings of other nature.

Recordings were made on 10-10 occassions, within a total of 2 x 500 m^2/60 min. at the water- and protected sides of the slopes, of dam proceeding in traced form in the level heights of the dam-side, and adapting to the phytocenoses. The recordings at the flood areas were performed at an area of 20 x 50 m^2. The zone-recordings lasted from March till the beginning of October, in compliance with the various aspects. During the course of the observations the coverage of the flowering meadow-plants and weeds was determined, related to area units. Throughout the studies, the flower-visiting sphere as well as the nectar- and pollen-collecting activity of the various wild bees were observed. During the course of the entomological recordings the wild bees collected on flowers were later identified, provided with appropriate data.

Studies on nectar-production were also carried out on the most important foster-plants flowering at the flood areas and dam-sides. 24 hours prior to the study the plants were covered with 2 mm meshed net. The nectar was collected with the help of the glass-capillary method (DEMIANOWICZ-HLYN, 1960). The weight of the nectar gained from the flowers was measured on torsion and analytical scale. Then the dry-matter (%) of the nectar blown out from the capillaries was determined with a Zeiss-Abbé type refractometer. The mean values of the nectar-production of the flowers were defined from the data of the nectar gained from generally 100 (max. 250) flowers.

Results

During the course of the vegetation period the bee pasture-land of an area is comosed of the plants producing pollen and nectar. The species-spectrum of the meadow-plants and weeds serving as energy-source for the wild bees is broader than in the case of the honey-bees. From the viewpoint of wild apiculture energy-source, pollen and nectar production of the bee pasture-land are better utilized compared to the honey-bees. During the course of the 12 years' study series the flowering plants and weeds meaning food source for the wild bees were mapped according to sections at the bee pasture-land. Table 1. demonstrates the relative pollen- and nectar-production as well as the end values of the flower coverage in the course of the aspects.

Table 1. Foster-plants for the wild bees in the terrestrial ecosystem of the Tisza–river.

(1) Foster-plants for the *Apoidea* insect populations at the dam and flood area of the Lower–Tisza reach

Taxon	N Sp.	N S.	N A. aspect	P Sp.	P S.	P A. aspect	F.c		
Consolida orientalis (GAY)	–	1	–	–	1	–	1	–	6
Clematis integrifolia L.				–	1	–			
Ranunculus repens L.	–	1	–	–	1	–	5	–	24
Ranunculus acris L.	–	1	–	–	1	–	1	–	10
Thalictrum flavum L.				–	1	–			
Rubus caesius L.	2	3	–	–	1	–	2	–	15
Potentilla anserina L.	1	–	–	2	1	1			
Potentilla reptans L.	1	–	–	2	–	–			
Sedum acre L.	1	–	–	1	–	–			
Medicago lupulina L.	1	2	1	1	1	1			
Medicago sativa L.	2	3	2	1	1	1	1	–	13
Medicago rigidula (L.)									
Melilotus officinalis LAM.	3	3	2	1	1	1	4	–	5
Trifolium aureum POLLICH	–	2	–	–	1	–			
Trifolium campestre SCHREB.	1	1	1	1	1	1	3	–	7
Trifolium hybridum L.	–	1	–	–	1	–			
Trifolium pratense L.	1	2	1	1	1	1	3	–	35
Trifolium repens L.	1	2	1	1	1	1	1	–	70
Tetragonolobus siliquosus (L.)	1	2	–	1	1	–			
Lotus corniculatus L.	1	2	2	1	1	1	1	–	22
Astragalus onobrychis L.									
Glycyrrhiza echinata L.	–	2	–				1	–	27
Coronilla varia L.				–	2	–	1	–	54
Onobrychis vicifolia SCOP.	3	1	–	1	1	–			
Vicia faba L.	1	2	–	1	1	–	3	–	9
Vicia tetrasperma (L.)	2	–	–	1	–	–	3	–	5
Vicia biennis L.									
Vicia villosa ROTH	–	1	–	–	1	–	12	–	20

Taxon	N Sp.	N S.	N A. aspect	P Sp.	P S.	P A. aspect	F.c		
Vicia cracca L.	–	2	–	–	1	–	1	–	70
Vicia lathyroides L.	1	2	–	1	1	–			
Vicia angustifolia GRUFB.	–	1	–	1	–	–	20	–	25
Lathyrus tuberosus L.	1	1	–	1	1	–	1	–	15
Lythrum virgatum L.	–	1	–	–	1	–	3	–	45
Lythrum salicaria L.	–	2	2	–	1	1	1	–	55
Oenothera biennis L.									
Eryngium campestre L.				–	1	–	2	–	45
Eryngium planum L.	–	1	1	–	1	1	2	–	23
Pastinaca sativa L.				–	1	–	1	–	15
Daucus carota L.	1	1	–	1	1	–	1	–	20
Dipsacus laciniatus L.	–	1	–	–	1	–	1	–	3
Knautia arvensis (L.)	1	1	–	1	1	–	2	–	6
Scabiosa ochroleuca L.				–	2	–	1	–	12
Altheae officinalis L.	–	1	–	–	2	–	2	–	18
Malva silvestris L.	–	1	–	–	1	1	8	–	15
Euphorbia lucida W. et K.	–	2	–				3	–	25
Euphorbia salicifolia HOST.	1	1	–	1	1	–	1	–	5
Asclepias syriaca L.	–	2	–	–	1	–	30	–	80
Convolvulus arvensis L.	–	1	–	–	1	–	1	–	40
Calystaegia sepium (L.)	2	–	–	1	–	–	1	–	3
Symphytum officinale L.	1	2	1	1	1	1	1	–	50
Anchusa officinalis L.									
Echium vulgare L.	–	3	2	–	1	1	8	–	10
Teucrium scordium L.	–	1	–	–	1	–			
Glechoma hederaceae L.	2	–	–	1	–	–	5	–	8
Prunella vulgaris L.	2	2	–	1	1	1	2	–	9
Lamium amplexicaule L.	1	–	–	1	–	–	1	–	13
Lamium purpureum L.	2	2	–	1	1	–	5	–	35
Ballota nigra L.	–	3	1	–	1	1	5	–	15
Stachys annua L.	–	2	1	–	1	1	1	–	9
Stachys palustris L.	–	1	1	–	1	–	3	–	10
Salvia nemorosa L.	1	3	–	1	1	–	2	–	50
Mentha aquatica L.	–	2	1	–	1	1	3	–	10
Mentha pulegium L.	–	3	2	–	1	1	5	–	15
Mentha verticillata L.	–	2	2	–	1	1			
Verbascum phlomoides L.				–	1	–	1	–	2
Linaria vulgaris MILL.	–	2	1	–	1	–	1	–	6
Plantago lanceolata L.				–	1	–	2	–	3
Papaver rhoeas L.				1	–	–	2	–	14
Brassica napus L.							2	–	5
Capsella bursa pastoris (L.)	1	1	–	1	1	1	2	–	17
Lepidium draba L.	1	1	–	1	1	–	5	–	80
Rorippa silvestris (L.)	1	1	1	1	2	1	2	–	9
Rorippa ausriaca (CR.)	–	1	–	–	1	1			
Bellis perennis L.							1	–	3
Stenactis annua (L.)	–	1	–	–	1	2	4	–	8
Stenactis strigosa (MÜHLENB.)			–	1	1	2	–	30	
Erigeron canadensis L.				–	1	–	2	–	22

Taxon	N Sp.	S.	A. aspect	P Sp.	S.	A. aspect	F.c		
Inula britannica L.	–	1	1	–	2	2	2	–	40
Xanthium italicum MOR.							4	–	15
Achillea millefolium L.				–	1	1	1	–	27
Matricaria chamomilla L.				1	1	–			
Matricaria inodora (L.)	–	1	–	2	2	–	1	–	16
Chrysanthemum vulgare (L.)				–	2	1	8	–	25
Senecio vulgaris L.							1	–	10
Arctium lappa L.	–	2	1	–	1	1	5	–	30
Carduus nutans	–	2	1	–	1	1			
Carduus acanthoides L.	–	2	1	–	1	1	4	–	75
Cirsium arvense (L.)	1	3	1	1	1	1	5	–	20
Cirsium canum (L.)	–	2	–	–	1	–			
Centaurea pannonica (HEUFF.)	–	2	–	–	1	1	5	–	35
Cichorium intybus L.	–	2	1	–	1	1	1	–	12
Leontodon automnalis L.				–	1	1	2	–	4
Taraxacum officinale F. WEBER	3	–	–	2	–	–	2	–	6
Crepis rhoeadifolia M.B.	–	1	1	–	2	1	5	–	17
Hieracium caespitum DUM.									
Silene vulgaris (MONCH.)				–	1	1	1	–	17
Melandrium album (MILL.)	–	1	–	–	1	–	1	–	7
Chenopodium album L.				–	1	–	1	–	3
Lysimachia nummularia L.				–	1	–			
Lysimachia vulgaris L.	–	1	–	1	1	–			
Salix triandra L.	2	–	–	1	–	–			
Salix caprea L.	3	–	–	1	–	–			
Gagea lutea (L.)	1	–	–	1	–	–	2	–	15
Ornithogallum umbellatum L.	1	–	–	1	–	–	1	–	2
Iris pseudacorus L.	1	1	–	1	–	–			

(2) Foster-plants for the *Apoidea* insect populations at the dam and flood area of the Middle–Tisza reach

Taxon	N Sp.	S.	A. aspect	P Sp.	S.	A. aspect	F.c		
Consolida orientalis (GAY)	–	1	–	–	1	–	1	–	7
Consolida regalis S. F. GRAY							2	–	3
Clematis integrifolia L.				–	1	–			
Ranunculus repens L.	–	1	–	–	1	–	1	–	5
Ranunculus acris L.	–	1	–	–	1	–	1	–	8
Thalictrum flavum L.				–	1	–			
Rubus caesius L.	2	3	–	–	1	–	2	–	16
Potentilla anserina L.	1	–	–	2	–	–			
Potentilla reptans L.	1	–	–	2	–	–			
Medicago lupulina L.	1	2	1	1	1	1	1	–	4
Medicago sativa L.	2	3	2	1	1	1	1	–	70

Taxon	N Sp.	N S.	N A. aspect	P Sp.	P S.	P A. aspect	F.c		
Medicago rigidula (L.)							1	–	2
Melilotus officinalis LAM.	3	3	2	–	1	1	2	–	7
Trifolium aureum POLLICH	–	2	–	–	1	–			
Trifolium campestre SCHREB.	1	1	1	1	1	1	3	–	5
Trifolium hybridum L.	–	1	–	–	1	–			
Trifolium pratense L.	1	2	1	1	1	1	1	–	30
Trifolium repens L.	1	2	1	1	1	1	2	–	15
Tetragonolobus siliquosus (L.)	1	2	–	1	1	–			
Lotus corniculatus L.	1	2	2	1	1	1	1	–	45
Astralagus onobrychis L.									
Glycyrrhiza echinata L.	–	2	–				5	–	7
Coronilla varia L.				–	2	–	1	–	4
Onobrychis viciifolia SCOP.	3	1	–	1	1	–			
Vicia faba L.	1	2	–	1	1	–	3	–	5
Vicia tetrasperma (L.)	2	–	–	1	–	–			
Vicia biennis L.									
Vicia villosa ROTH	–	1	–	–	1	–	1	–	20
Vicia cracca L.	–	2	–	–	1	–	1	–	6
Vicia lathyroides L.	1	2	–	1	1	–			
Vicia angustifolia GRUFBA.	–	1	–	1	–	–			
Lathyrus tuberosus L.	1	1	–	1	1	–	1	–	14
Lythrum virgatum L.	–	1	–	–	1	–	1	–	7
Lythrum salicaria L.	–	2	2	–	1	1	3	–	4
Oenothera biennis L.									
Eryngium campestre L.				–	1	–	3	–	15
Eryngium planum L.	–	1	1	–	1	1	3	–	10
Pastinaca sativa				–	1	–	3	–	35
Daucus carota L.	1	1	–	1	1	–	1	–	55
Dipsacus laciniatus L.	–	1	–	–	1	–	1	–	5
Knautia arvensis (L.)	1	1	–	1	1	1			
Scabiosa ochroleuca L.				–	2	1	2	–	18
Althaea officinalis L.	–	1	–	–	2	–	4	–	5
Malva silvestris L.	–	1	–	–	1	1	2	–	6
Euphorbia lucida W. et K.	–	2	–				1	–	3
Euphorbia salicifolia HOST.	1	1	–	1	1	–	4	–	6
Asclepias syriaca L.	–	2	–	–	1	–	2	–	15
Convolvulus arvensis L.	–	1	–	–	1	–	1	–	20
Calystagia sepium (L.)	2	–	–	1	–	–	2	–	6
Symphytum officinale L.	1	2	1	1	1	1	3	–	28
Anchusa officinalis L.									
Echium vulgare L.	–	3	2	–	1	1	2	–	18
Teucrium scordium L.	–	1	–	–	1	–			
Glechoma hederacea L.	2	–	–	1	–	–	2	–	5
Prunella vulgaris L.	2	2	–	1	1	1	4	–	12
Lamium amplexicaule L.	1	–	–	1	–	–	1	–	10
Lamium purpureum L.	2	2	–	1	1	–	2	–	15
Ballota nigra L.	–	3	1	–	1	1	5	–	25
Stachys annua L.	–	2	1	–	1	1	2	–	5

Taxon	N Sp.	S.	A. aspect	P Sp.	S.	A. aspect	F.c		
Stachys palustris L.	–	1	1	–	1	–	5	–	25
Salvia nemorosa L.	1	3	–	1	1	–	1	–	3
Mentha aquatica L.	–	2	1	–	1	1	5	–	60
Mentha pulegium L.	–	3	2	–	1	1	1	–	25
Mentha verticillata L.	–	2	2	–	1	1			
Verbascum phlomoides L.				–	1	–	2	–	4
Linaria vulagaris MILL.	–	2	1	–	1	–	1	–	7
Plantago lanceolata L.				–	1	–	1	–	5
Papaver rhoeas L.				1	–	–	1	–	6
Brassica napus L.							6	–	8
Lepidium draba L.	1	1	–	1	1	–	2	–	30
Capsella bursa-pastoris (L.)	1	1	–	1	1	1			
Rorippa silvestris (L.)	1	1	1	1	2	1	2	–	25
Rorippa austriaca (CR.)	–	1	–	–	1	1			
Bellis perennis L.									
Stenactis annua L.	–	–	1	–	1	2	3	–	8
Stenactis strigosa (MÜHLENB.)							5	–	7
Erigeron canadensis L.				–	1	–			
Inula britannica L.	–	1	1	–	2	2	1	–	15
Xanthium italicum MOR.							2	–	25
Achillea millefolium L.				–	1	1	4	–	6
Matricaria chamomilla L.				1	1	–			
Matricaria inodora (L.)	–	1	–	2	2	–	1	–	15
Chrysanthemum vulgare (L.)				–	2	1	12	–	25
Senecio vulgaris L.							1	–	5
Arctium lappa L.	–	2	1	–	1	1	3	–	8
Carduus nutans L.	–	2	1	–	1	1	4	–	20
Carduus acanthoides L.	–	2	1	–	1	1	1	–	85
Cirsium arvense (L.)	1	3	1	1	1	1	1	–	6
Cirsium canum (L.)	–	2	–	–	1	–			
Centarurea pannonica HEUFF.	–	2	–	–	1	1	1	–	5
Cichorium intybus L.	–	2	1	–	1	1	1	–	25
Leontodon autumnalis L.				–	1	1	4	–	15
Taraxacum officinale F. WEBER	3	–	–	2	–	–	1	–	5
Crepis rhoeadifolia M. B.	–	1	1	–	2	1	2	–	13
Silene vulgaris (MÖNCH.)				–	1	1	10	–	50
Melandrium album (MILL.)	–	1	–	–	1	–	1	–	3
Chenopodium album L.				–	1	–	2	–	4
Lysimachia nummularia L.				–	1	–			
Lysimachia vulgaris L.	–	1	–	1	1	–			
Salix triandra L.	2	–	–	1	–	–			
Salix caprea L.	3	–	–	1	–	–			
Gagea lutea (L.)	1	–	–	1	–	–	1	–	35
Ornithogallum umbellatum L.	1	–	–	1	–	–	1	–	3
Iris pseudacorus L.	1	1	–	1	1	–			

(3) Foster-plants for the *Apoidea* insect populations at the dam and flood area of the Upper-Tisza reach

Taxon	N Sp.	N S.	N A. aspect	P Sp.	P S.	P A. aspect	F.c		
Ranunculus repens L.	–	1	–	–	1	–	1	–	2
Ranunculus acris L.	–	1	–	–	1	–	1	–	4
Rubus caesius L.	2	3	–	–	1	–	5	–	23
Potentilla anserina L.	1	–	–	2	1	1			
Potentilla reptans L.	1	–	–	2	–	–			
Medicago lupulina L.	1	2	1	1	1	1			
Medicago sativa L.	2	3	2	1	1	1			
Medicago rigidula (L.)									
Melilotus officinalis LAM.	3	3	2	1	1	1	2	–	4
Trifolium aureum POLLICH	–	2	–	–	1	–			
Trifolium campestre SCHREB.	1	1	1	1	1	1	3	–	4
Trifolium hybridum L.	–	1	–	–	1	–			
Trifolium pratense L.	1	2	1	1	1	1	1	–	16
Trifolium repens L.	1	2	1	1	1	1	3	–	30
Lotus corniculatus L.	1	2	2	1	1	1	1	–	15
Glycyrhizza echinata L.	–	2	–				4	–	12
Coronilla varia L.				–	2	–	3	–	5
Vicia tetrasperma (L.)	2	–	–	1	–	–			
Vicia villosa ROTH	–	1	–	–	1	–			
Vicia cracca L.	–	2	–	–	1	–	3	–	14
Vicia lathyroides L.	1	2	–	1	1	–			
Vicia angustifolia GRUFB.	–	1	–	1	–	–			
Lathyrus tuberosus L.	1	1	–	1	1	–	3	–	8
Lythrum virgatum L.	–	1	–	–	1	–			
Lythrum salicaria	–	2	2	–	1	1	4	–	5
Eryngium planum L.	–	1	1	–	1	1			
Pastinaca sativa L.				–	1	–	2	–	12
Daucus carota L.	1	1	–	1	1	–	2	–	17
Knautia arvensis (L.)	1	1	–	1	1	–	1	–	35
Scabiosa ochroleuca L.				–	2	–	3	–	22
Althaea officinalis L.	–	1	–	–	2	–			
Malva silvestris L.	–	1	–	–	1	1			
Euphorbia lucida W. et K.	–	2	–				3	–	15
Euphorbia salicifolia HOST.	1	1	–	1	1	–	2	–	3
Convolvulus arvensis L.	–	1	–	–	1	–	1	–	5
Calystegia sepium (L.)	2	–	–	1	–	–			
Symphytum officinale L.	1	2	1	1	1	1	1	–	6
Echium vulgare L.	–	3	2	–	1	1	2	–	8
Glechoma hederacea L.	2	–	–	1	–	–	3	–	6
Prunella vulgaris L.	2	2	–	1	1	1	3	–	9
Lamium purpureum L.	2	2	–	1	1	–	1	–	15
Ballota nigra L.	–	3	1	–	1	1	10	–	20
Stachys annua L.	–	2	1	–	1	1			
Stachys palustris L.	–	1	1	–	1	–	1	–	6
Salvia nemorosa L.	1	3	–	1	1	–	5	–	7
Mentha aquatica L.	–	2	1	–	1	1			
Mentha pulegium L.	–	3	2	–	1	1	1	–	6

Taxon	N Sp.	N S.	N A.	P Sp.	P S.	P A.	F.c		
	aspect			aspect					
Mentha verticillata L.	–	2	2	–	1	1			
Verbascum phlomoides L.				–	1	–			
Linaria vulgaris MILL.	–	2	–	–	1	–	1	–	4
Plantago lanceolata L.				–	1	–			
Papaver rhoeas L.				1	–	–			
Lepidium draba L.	1	1	–	1	1	–	1	–	20
Capsella bursa-pastoris L.	1	1	–	1	1	1	1	–	5
Rorippa silvestris (L.)	1	1	1	1	2	1	1	–	5
Rorippa austriaca (CR.)	–	1	–	–	1	1			
Bellis perennis L.									
Stenactis annua (L.)	–	–	1	–	1	2			
Stenactis strigosa (MÜHLENB.)				–	1	1			
Erigeron canadensis L.				–	1	–	2	–	18
Inula britannica L.	–	1	1	–	2	2	2	–	9
Xanthium italicum MOR.									
Achillea millefolium L.				–	1	1	2	–	15
Matricaria chamomilla L.				–	1	1			
Matricaria inodora (L.).	1	1	–	2	2	–	2	–	30
Chrysanthemum vulgare (L.)				–	2	1	6	–	7
Senecio vulgaris L.							1	–	20
Arctium lappa L.	–	2	1	–	1	1	4	–	15
Carduus acanthoides L.	–	2	1	–	1	1	5	–	15
Cirsium arvense (L.)	1	3	1	1	1	1	3	–	5
Cirsium canum (L.)	–	2	–	–	1	–			
Centaurea pannonica (HEUFF.)	–	2	–	–	1	1	2	–	26
Cichorium intybus L.	–	2	1	–	1	1	3	–	5
Leontodon autumnalis L.				–	1	1	2	–	8
Taraxacum officinale F. WEBER	3	–	–	2	–	–	1	–	6
Crepis rhoeadifolia M. B.	–	1	1	–	2	1	1	–	7
Silene vulgaris (MÖNCH.)				–	1	1	2	–	23
Melandrium album (MILL.)	–	1	–	–	1	–	1	–	8
Lysimachia vulgaris L.	–	1	–	1	1	–			
Salix triandra L.	2	–	–	1	–	–			
Salix caprea L.	3	–	–	1	–	–			
Gagea lutea (L.)	1	–	–	1	–	–	1	–	10
Ornithogallum umbellatum L.	1	–	–	1	–	–	1	–	2

Abbreviations:
N = nectar
P = pollen
Sp = Spring aspect
S = Summer aspect
A = Autumn aspect
1. 2. 3. = Relative ratios of the pollen and nectar-production
F.c = Percentage of flower coverage

1. THE IMPORTANT FOSTER-PLANTS OF THE TERRESTRIAL BIOTOPES AT THE LOWER-TISZA REACH

Among the willows the *Salix triandra* forms a flowering set throughout spring. At Körtvélyes island and the Alpár meadow it flowers in April–May and produces pollen and nectar. It is firstly favoured by the *Andrena* species. The willows are in genaral the ligneous plants of the flood- meadow areas, producing the important spring pollen and nectar (HALMÁGYI and KERESZTESI, 1985). The *Lamium purpureum* and *Lamium amplexicaule* are also plants of the flood-area, producing exposed pollen and nectar. They are significant honey-makers (GULYÁS, 1968), however, owing to their long corollate tube, only the long-tongued *Osmia*, *Hoplitis*, *Eucera* and *Anthophora* species with more developed mouth organ are able to suck nectar from them. The *Glechoma hederaceae* is a plant flowering only in spring. The opinions are divergent regarding the nectar-production of this species. It is favoured by the long-tongued wild bee species. The *Potentilla anserina*, *Potentilla reptans* firstly produce pollen, but nectar as well in smaller degree. They are visited by the small-bodied *Halictus* and *Lasioglossum* species. In April–May the *Taraxacum officinale* is one of the most important nectar- and pollen-producing plants at the grass-slope. The individuals of the *Andrena*, *Halictus*, *Lasioglossum*, *Bombus*, *Megabombus*, *Pyrobombus* species collect from its flowers. In the case of the *Compositae* species the abundant nectar production is the result of the joint secretion of the many flowers (PESTI, 1980). The *Lepidium draba* flowers with great coverage at the slopes of dam at the end of Spring in May and June, with a percental value between 5–80. It was particularly favoured by the bumble-bees, but the other wild bees species also visited it in large numbers. Its nectar is easily approachable by the wild bee species with shorter mouth organs, too. The *Vicia* species are also good honey-makers at the end of spring, however, with the exception of the extrafloral nectarians, only few taxa are capable of sucking nectar from the flower apart from the species of the *Osmia*, *Hoplitis*, *Eucera* and *Anthophora* genera, due to the long corollate tube. Prior to the first mowing the *Vicia cracca* also flowers in large numbers at the flood areas, at places even reaching a coverage of 70%. According to our experiences the *Osmia*, *Eucera* and *Anthophora* species of short swarming period in spring and with long mouth organs have adapted to the long corollate tubed labiate flowers, as well as to a few papilionaceae during the course of the coevolution. The *Salvia nemorosa* flowers in great numbers at the end of spring. Its coverage even reached 50% at certain places. It is a good honey-making plant (GULYÁS, 1968). The *Convulvulus arvensis* even reached a coverage of 40% on occassions at the end of spring, mainly at the top of the dam. It firstly provides pollen for the species of the *Systropha*, *Halictus*, *Lasioglossum* genera. At the end of the spring aspect the *Capsella bursa-pastoris* and the *Rorippa silvestris* produce pollen and nectar. These are firstly favoured by the male *Andrena* individuals.

The mass flowering of the *Lotus corniculatus* is at the beginning of summer. It is an abundant nectar-source for the species of the *Chalicodoma*, *Megachile*, *Andrena*, *Bombus*, *Megabombus* genera, but its pollen-production is also significant. The *Lotus*

corniculatus maintains itself even for 15–20 years in the mixture of pasture and meadow, by means of its own seed rotation (SAS, 1956). In summer the *Coronilla varia* even reaches a coverage of 55% occassionally, in patches. Owing to its abundant pollen-production, the agriculturally also valuable *Andrena ovatula* and *Andrena labialis* species prefer this plant. In June–July the *Lathyrus tuberosus* is favoured by the species of the *Chalicodoma*, *Megachile*, *Andrena* genera. Following the subsidence of the spring inundations this plant sometimes even flowers with a coverage of 15% at the inner side of the slopes of dam covered with water and on the alluvial soil of the flood areas. The *Symphytum officinale* is preferably significant at the water-side slope of dam and the flood area, firstly giving nectar; and pollen to a smaller extent. At the surveyed area the average daily nectar-production of a flower was 12.3 mg, its sugar percentage was 25, and the sugar value 3.16 mg. This proved to be the most valuable foster-plant during the course of the measured nectar-production studies (Table 2). HALMÁGYI and SUHAJDA (1963) studied the honey-making of the *Symphytum officinale* at the Southern Danube flood area. There the nectar production showed values between 2.0–4.9, and the sugar value 0.7–1.1 mg. However, the values measured by the authors proved to be higher close to the Tisza. Its flower coverage is high at places (50%), blooming continuously and being one of the best food-sources for the wild bee populations during the course of vegetation. At the end of spring, beginning of summer it was favoured

Table 2. Nectar-production of the studied species

Name	No. of flowers	Nectar		
		mg/24h	sugar %	sugar value 24h/sugar/mg
Salvia nemorosa	493	6.09	36.05	2.19
Lotus corniculatus	52	4.50	24.25	1.09
Lathyrus tuberosus	23	2.41	16.16	0.38
Medicago sativa	140	3.93	28.50	1.12
Trifolium pratense	135	4.18	33.62	1.40
Vicia villosa	84	1.70	21.62	0.36
Symphytum officinale	177	12.37	25.59	3.16
Lythrum virgatum	99	2.93	22.71	0.66
Echium vulgare	129	8.55	18.97	1.62

firstly for its nectar by the agriculturally also significant species of the *Andrena*, *Eucera*, *Melitta*, *Tetralonia*, *Bombus*, *Megabombus*, *Pyrobombus* genera. The *Salvia nemorosa* continuously blooms even during summer. The flowers collected from the study area showed average nectar-production of 6.0 mg, sugar percentage of 36.0 and sugar value of 2.1 mg. Besides the *Symphytum officinale*, this is the second most valuable foster-plant at the study area. At the flood areas and stagnant-watered meadows the *Lythrum salicaria* — at places with a coverage of 45% — is the primary foster-plant for the *Melitta nigricans*, *Melitta tricincta*, *Tetralonia nana*, *Tetralonia salicariae* and the *Tetralonia ruficornis*. It is considered to be an excellent nectar- and pollen-producing plant by NYÁRÁDI (1958).

The *Echium vulgare* is the drought-resistant plant of the Eastern, South–eastern slopes of dam giving abundant nectar and pollen in the middle of summer. It is an important foster-plant for the species of the *Bombus*, *Megabombus*, *Pyrobombus*, *Hoplitis* genera. At the surveying site at Tiszasziget one flower of the *Echium vulgare* produces an average of 8.55 mg nectar, with a sugar content of 18.9%. According to observations it was favoured in the greatest number by the honey-bees. On the basis of findings by DEMIANOWICZ (1953) it produces 250–300 kg honey at 1 ha in Poland. The flower coverage of the *Lythrum virgatum* is maximally 45%. It produces pollen and nectar, and favours the drier parts of flood areas of higher terraces. One flower produces 2.9 mg nectar, with a sugar percentage of 22.71. The composition of its flower-visiting insect population is similar to that of the *Lythrum salicariae*. In summer the flower of the *Vicia villosa* is the nectar and pollen source for the wild bee populations. It is firstly favoured by the species of the *Andrena*, *Anthidium*, *Paraanthidium* genera. The average nectar-production of a *Vicia villosa* flower is 1.7 mg, its sugar percentage is 21.6. This nectar-production is the lowest among the studied foster-plants. The *Vicia cracca* flowers in a shrub-like manner at the flood areas on the pioneer soils. Its coverage was maximally 70% in an area unit of 50 m^2. The vetch species are preferred by the species of the *Megachile*, *Chalicodoma*, *Andrena*, *Anthidium*, *Xylocopa*, *Bombus*, *Megabombus* genera, firstly for the purpose of nectar collection. The white clover blooms continuously in summer with great coverage (70%). According to observations by KOPELKIEVSZKIJ (1965), the blooming of the white clover lasts for about 90 days. BURMISZTROV (1959) measured the sugar-production of the *Trifolium repens* at meadow plantations and found it to be 8 kg per hectare. It is favoured for its nectar by the *Andrena ovatula*, *Andrena labialis* and *Andrena flavipes* species. The size of the pollen-collections is also significant in the case of the above mentioned species. The flowers of the *Trifolium repens* were firstly favoured by the hive bees at the surveying sites. In summer the *Medicago sativa* occurred with smaller, while the *Trifolium pratense* with higher coverage. The structure of their flower-visiting wild bee populations shows great overlapping. The humble-bees prefer the red clover for pollen. The wild bees collect nectar on the flower of the *Medicago sativa*.

The *Eryngium campestre* flowers with great coverage in the second half of summer at the protected side of the embankments. It is favoured in great numbers by the *Andrena variabilis*, firtsly collecting pollen from the flowers. The *Inula*

britannica is mostly liked for its pollen, as well as for nectar by the species of the *Tetralonia*, and *Melitta* genera in the second half of the summer. The *Carduus acanthoides* produces nectar and pollen, also in the second half of summer. Its flowers are favoured by the species of the *Halictus*, *Lasioglossum*, *Bombus*, *Pyrobombus* and *Megabombus* genera. The *Mentha aquatica* is also a good honey-maker, with a coverage of 10% at the stagnant-watered flood area meadows, following the subsidence of the inundations (GULYÁS, 1968). The *Cichorium intybus* blooms in the second half of summer, producing both nectar (PÉTER, 1973) and pollen. According to our studies, the *Halictus simplex*, *Halictus maculatus* and the *Andrena flavipes* firstly collected pollen on its flowers. Although being a good honey-maker, the *Cirsium arvense* (PÉTER, 1973) was only liked by few wild bee species. The *Crepis rhoeadifolia* was favoured by the *Halictus* and *Lasioglossum* species.

At the time of the autumn blooming aspect the number and degree of coverage of the flowering meadow-plants and weeds decreased from wild apicultural point of view. Only few flowers produce nectar by the middle of September. The flowering plants were mostly preferred by the wild bees pollen at this time. In the first half of September the *Lotus corniculatus* blooms alongside the L–T. reach, where it still produced nectar intensively (TANÁCS, 1979). The *Eryngium campestre* showed mass flowering frequently even till the middle of September, its pollen-production being significant for the *Andrena* species even at this time. At the beginning of autumn the most important foster-plants for the *Dasypoda* species are the *Knautia arvensis* and the *Scabiosa ochroleuca*. The flower of the latter plant was liked for pollen by the individuals of the *Dasypoda plumides*. From the viewpoint of the wild bees, one of the most important foster-plants in the autumn blooming aspect is the *Centaurea pannonica*. At Tiszasziget its coverage per area unit proved to be maximally 35%. It was favoured for pollen by the species of the *Halictus*, *Lasioglossum*, *Bombus*, *Megabombus* and *Psithyrus* genera.

2. THE MOST IMPORTANT FOSTER-PLANTS OF THE TERRESTRIAL BIOTOPES AT THE MIDDLE–TISZA REACH

In the biotopes near the catchment area the species-combination of the meadow-plants and weeds is more limited at certain areas, owing to the large surfaced red clover and lucerne resowing. At the bee pasture-land, the species number of the nectar- and pollen-producing plants was 104. At the flood area, prior to the banking up, the pollen- and nectar-production of the *Potentilla anserina* and *Potentilla reptans* provides food for the small-bodied wild bee species, like the individuals of the *Lasioglossum* genus, during the spring aspect. Following the establishment of the dam-system the coverage of the *Salix triandra* and other willow species is not significant during the spring aspect. At the flood area, in 1976–1977, the spring labiates, like the *Glechoma hederaceae*, *Lamium purpureum*, *Lamium amplexicaule* and *Prunella vulgaris*, had significant coverage. The *Prunella vulgaris* is also a good honey-maker (GULYÁS, 1968), even capable of producing 175 kg of honey per hectare. The *Vicia lathyroides*, *Vicia villosa* (20%), *Vicia cracca* (5%) and *Vicia*

angustifolia flower alongside the catchment area at the end of May and beginning of June. The coverage of the *Lepidium draba* during the course of the recordings alongside the catchment area even reached 30%, thus proving to be the most significant foster-plant of the spring aspect. The resowing of the various kinds of clovers is characteristic in places at the newly established dams. The *Trifolium repens* blooms at the more humid parts. The flower of the white clover excretes nectar with a concentration of 40% and sugar value of 0.04% (BEUTLER and SCHÖNTAG, 1940). DEMIANOWICZ (1953) refers to the fact that 1 ha of white clover even gives 100 kg honey-production. KOPELKIEVSZKIJ (1954) reports on similar results. According to our observations the white clover is favoured by the *Andrena* species and rarely by the *Halictus*, *Lasioglossum*, *Bombus*, *Megabombus* individuals. At the beginning of summer the *Trifolium pratense* is also in mass bloom. One flower of the red clover collected from the fill slope showed an average nectar-production of 4.1 mg, a sugar percentage of 33.6 mg and a sugar content of 1.4 mg. Since it flowers in dense clusters, it exerts strong attractive effect on the agriculturally also significant wild bee species. The species of the *Andrena*, *Eucera*, *Bombus*, *Megabombus* and *Pyrobombus* genera were found in great masses on the red clover. It had already been demonstrated earlier that there is a positive correlation between the quality of the nectar and the bee density (KROPACOVA, 1960).

The other significant resown papilionaceous agroculture was the *Medicago sativa*. Its maximal coverage reached 70%. Its nectar-production proved to be less than that of the *Trifolium pratense* according to our studies. The composition of the flower-visiting wild bee populations of the lucerne is similar to that of the red clover. During the course of studies the *Melitta leporina* proved to be a significant lucerne-visiting wild bee. In the first half of summer the *Brassica napus* is frequent at the saved-side of the embankment. It was favoured by the species of the *Halictus*, *Lasioglossum*, *Andrena*, *Bombus*, *Megabombus* genera. According to our observations these collect both nectar and pollen. During the course of the Lotus corniculatus resowings significant coverage develops (45%). This plant is an important pollen- and nectar-source in the regions of Poroszló and Tiszanána, as well as at the higher parts of the flood area. At these areas the coverage of the *Daucus carota* is also considerable, even reaching 55%, however, it is not significant for the wild bees. It was favoured by the *Hylaeus* and *Halictus* species. In the case of the labiates the *Stachys annua*, at more humid areas the *Stachys palustris* mean significant pollen- and nectar-source for the humble bees. There is a large amount of nectar even in the withering flowers of the *Stachys* species (GULYÁS, 1968). The *Prunella vulgaris* produces honey during the course of summer. Its coverage was of 12% at the deeper parts of the flood area and water-side slopes of the dam. Compared to the area alongside the L–T. reach, the *Mentha aquatica* bloomed at an essentially larger area in the terrestrial biotopes of the M–T. reach, at the flood area meadows in the region of Poroszló and Tiszanána. Its coverage even reached a maximum of 60%. At the protected side the *Ballota nigra* favours the areas of higher part. Its greatest coverage was 25%. It was favoured by the humble bees in large numbers which firstly collected nectar from the flowers. During the course of its long-lasting blooming it is the

abundant nectar-producing plant of the late summer (GULYÁS, 1968). The *Lythrum salicaria* and the *Lythrum virgatum* flower at the flood areas and riverside from July. The coverage of the willow species is not considerable, however, the enrichment of the *Tetralonia ruficornis*, as well as the *Tetralonia salicariae*, *Tetralonia nana*, *Melitta tricincta* and *Melitta nigricans* is significant on the flowers of the *Lythrum* species in the second half of summer. The coverage of the *Symphytum officinale* is significant at this study area, too (38%), although being less than alongside the L–T. reach. The enrichment of the *Echium vulgare* was observable on the left side of the slope of the dam along the catchment area, in South, South–eastern direction on the protected side. At this Tisza reach the coverage of the *Inula britannica* is significant in the second half of summer, prior to banking up. In the summer of 1976 the *Carduus acanthoides* also had great coverage (85%) in the region of Tiszaszőlős and Tiszaderzs, as the consequence of the discontinuance of mowings. Its flowers were favoured by the species of the *Bombus*, *Megabombus*, *Pyrobombus*, *Halictus* and *Lasioglossum* genera. This plant species produces both nectar and pollen, and has strongly attractive effect, distracting the agriculturally significant *Halictus simplex* and *Lasioglossum malachurum* species from the agrocultures of the back areas. The flower of the *Crepis rhoeadifolia* is an important nectar source for the gracile bees at the end of summer. At this period the *Cichorium intybus* also shows considerable enrichment. The coverage of the *Scabiosa ochroleuca* is significant at the end of summer and beginning of autumn. It serves as a pollen-source for the *Dasypoda plumipes* at this area, too. The *Eryngium campestre* occurs at the Eastern, South–eastern fill slopes. Following second mowing the red clover only serves as a pollen-source for the *Andrena* species. The *Rorippa silvestris* is favoured by the *Andrena* species and a few *Lasioglossum* individuals at the end of summer, and beginning of autumn. From the middle of September the nectar secretion of the flowers is decreased, or has completely ceased (GULYÁS, 1968). The *Carduus nutans*, *Crepis rhoeadifolia* and *Cichorium intybus* are important as pollen-producing plants. The *Chrysanthemum vulgare* blooms on the water-side, everywhere along the bank in a zone of 1–2 km. It was favoured by the *Hylaeus*, *Colletes* and *Lasioglossum* species. In the second half of September it is by a great number of the parasite *Sphecodes* species. According to our experiences, the parasite species favour the flowers of the heavily-scented meadow-plants and weeds with great preference.

3. THE MOST IMPORTANT FOSTER-PLANTS OF THE TERRESTRIAL BIOTOPES AT THE UPPER–TISZA REACH

The species-combination of the flowery meadow-plants and weeds of the bee pasture-land is poorer than at the former areas. Here, 83 flowering plants serve as bee pasture-land for the wild bees. The *Rubus caesius* is important at the end of the spring aspect. The foster-plants for the wild bees at the flood areas at the end of spring are the *Potentilla* species. They only produce nectar in small quantities. They are mainly favoured for pollen by the small body-sized *Halictus* (= *Seladonia* subgenus) and *Lasioglossum* species. The *Lepidium draba* appears in great masses

at the slopes of dam in May. At Tokaj, in front of the settlement, the *Taraxacum officinale*, *Vicia* species, *Rorippa silvestris* and *Lepidium draba* proved to be the most significant foster-plants. In the 2. zone at Tokaj the exposed nectar- and pollen-producing species at the flood area are the *Lamium purpureum*, *Glechoma hederaceae* and the *Prunella vulgaris*. The flower of the *Knautia arvensis* blooms in masses at the slopes of the dam of the 2. zone at Tokaj. The *Andrena hattorfiana* collects pollen in masses alongside the U–T. reach, prior to the first mowing. According to our observations the *Andrena hattorfiana* flew in masses from the flowers of the *Knautia arvensis* located at the fill slopes in the region of Jánd–Gulács to the apple-orchards of the neighbouring back areas. The apple-blossom pollinating activity of the *Andrena* species has also been observed in Tirol by SCHRECK and SCHEDL (1979).

At the end of the spring aspect the flower of the *Rorippa silvestris* was favoured by the male individuals of the *Andrena carbonaria*, *Andrena chrysoscelles* and *Andrena ovatula*.

In the summer aspect, prior to the second mowing, the maximal coverage of the white clover was 30%. At the surveyed-site of the 1. zone at Tokaj the joint flower coverage of the *Lotus corniculatus*, *Trifolium pratense*, *Vicia cracca* and *Lathyrus tuberosus* significantly ensured the continuous pollen- and nectar-source for the wild bees. At Tokaj the flowers of the *Lythrum salicaria* and *Lythrum virgatum* were preferred by the *Melitta tricincta*, *Melitta nigricans* and the *Tetralonia nana*. During summer, the important foster-plant at the protected side is the good honey-making *Ballota nigra* with a coverage of 30%, and at the water-side the *Matricaria inodora* with a maximal coverage of 30%. In the 1. zone at Tokaj the *Chrysanthemum vulgare* is significant at the end of summer, along the bank. These resulted the enrichment of the species of the pollen-swallowing *Hylaeus* as well as the *Colletes* genera. The riverside plant of the 2. zone is the *Stachys palustris*. The species of the *Compositae* plant family play important role in the structure of the bee pasture-land from the second half of the summer. In the 1. zone at Tokaj, on the protected side the *Arctium lappa*, while at the slope of the dam between Jánd–Tarpa the *Carduus acanthoides* species form greater set. Nectar and pollen were collected on the flower of the *Centaurea pannonica* by a few species of the *Andrena limata*, the *Halictus* and the *Lasioglossum*. At Tokaj, as well as the section between Jánd–Tarpa, the flowers of the *Euphorbia lucida* were favoured by the *Hylaeus* species. In the 1. and 2. zones at Tokaj the enrichment of the *Inula britannica* was significant in places. The coverage of the *Knautia arvensis* and *Scabiosa ochroleuca* is greater than in the terrestrial biotopes alongside the L–T. and M–T. reaches.

In respect to the biotopes of the U–T. reach, it was firstly observed in the summer aspect that the xerophyta and mesoxerophyta flowery weeds had essentially smaller coverage than at the terrestrial biotopes alongside the L–T. or M–T. reaches. It follows from this that their significance also decreases at the bee pasture-land. This firstly relates to the *Salvia nemorosa*, *Eryngium campestre*, *Echium vulgare* and certain *Trifolium* as well as *Vicia* species. According to our experiences during the

course of the studies along the U–T. reach, the vegetation period is shorter, which can be explained by climatic reasons. The wild bee species with wide ecological valency have the highest ratio here in the evaluations per section.

The species combination of the foster-plants is limited in the autumn flowering aspect. At the flood areas the *Chrysanthemum vulgare*, while at the slopes of dam from the second half of September, only the pollen-producing *Carduus* species, the *Crepis rhoeadifolia*, *Cichorium intybus*, *Centaurea pannonica* form more important food source. The exceptions to this finding were the pollen- and scanty nectar-producing *Trifolium pratense* and *Medicago sativa* stands, resown at the different sections, and being before the 3. mowing.

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REVISION OF THE *FULVIPES*-, *RUFICORNIS*- AND *VARIEGATA*-GROUPS OF THE GENUS *CEROPALES* LATREILLE (*HYM., CEROPALIDAE*)

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Abstract

This revisionary study treats the 12 species of the *FULVIPES*-, *RUFICORNIS*- and *VARIEGATA*-group of *Ceropales* s. str. occurring in the Nearctic, Palearctic and in the Ethiopian regions. *Ceropales tokyoensis* and *saltoensis* are described as new species from Japan and from Mexico, respectively and the male of *C. ruficollis* CAMERON is described for the first time. Names are synonymized as follows: *Ceropales ruficornis* GUSSAKOVSKIJ = *C. gilvus* HAUPT jun. syn., *C. variegata* (FABRICIUS) = *C. impunctatus* YASUMATSU jun. syn., *C. picta* SHUCKARD = *C. ruficollis* CAMERON sensu ARNOLD jun. syn., and *C. latifasciatus montivagus* ARNOLD jun. syn., and *C. ruficollis* CAMERON = *C. latifasciatus* var. *jucundus* ARNOLD ♀ jun. syn. *C. ruficollis* CAMERON is revalidated as bona species from the synonymy. Lecto- and paralectotypes are designated.

A revision of the large genus *Ceropales* s.l. has become necessary because the new systematic arrangement based chiefly on the claws (PRIESNER, 1969) and especially on account of the new descriptions prepared during the period of the Second World War, since at that period it was impossible to study the types, as well as the literature references were not avaliable, either. In this process the following names have been synonymized: *Ceropales gilvus* HAUPT, *C. impunctatus* YASUMATSU, *C. ruficollis* CAMERON sensu ARNOLD, *C. latifasciatus* var. *jucundus*. *C. ruficollis* CAMERON has been revalidated from synonymy as bona species. Lecto and paralectotypes have been designated in the original series for a number of species. To facilitate future correct recognition of the type specimens, I give the exact data of the different labels of the investigated types in quotation marks. Similarly to TOWNES's (1957) *FULVIPES*-group, I combine some species known only sporadically today into the *RUFICORNIS*- and *VARIEGATA*-group. Recognition of these three groups is rather easy among the species of *Ceropales* s. str., howewer identification of the species is much more difficult in certain cases. Instead of the usual long and detailed descriptions I summarized the most typical characteristics in the key for the unambiguous recognition of the often rather variable species. This study treats 12 species, two among them being new to science, occuring in Nearctic, Palearctic and in Ethiopian regions. All references, which are absent from the DALLA TORRE's (1897) catalogue have been listed as far as possible.

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Key of the species (♀♂)

1 Surface of propodeum smooth only basally, or coarsely rugose (figs 1,3), or at least rugulose on its whole length. Propodeum strongly broken basally and in lateral view flat or concave on declivous part. Frons moderately, pronotum, especially mesonotum remarkably deeper and more densely punctured, sometimes partly shining. Claws of hind legs rectangularly curved 2

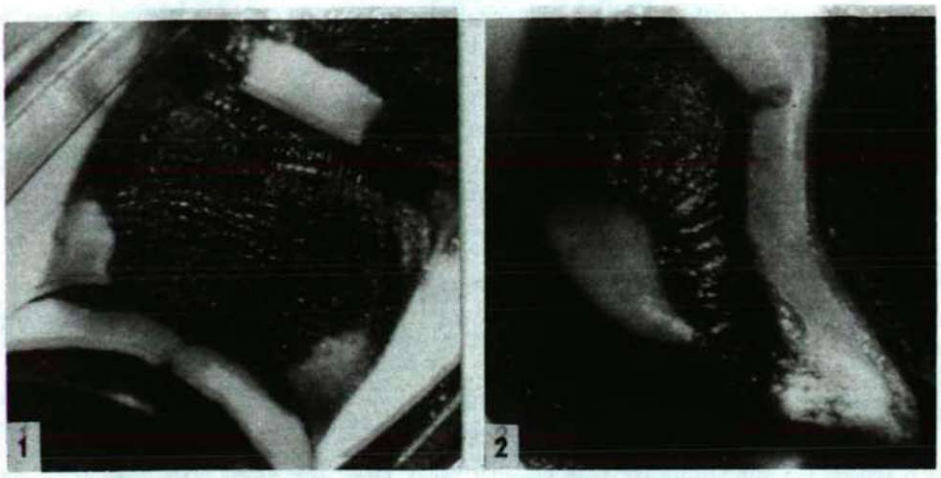
– Propodeum, frons, pronotum and mesonotum finely sculptured, coriaceous-granulated (fig. 4), pruinose, mat, never rugose or rugulose. In lateral view surface of propodeum moderately convex anteriorly or on its whole length. Tergite 2 or 3–6 often black. Hind claws rectangularly curved (*VARIEGATA*-group) 8

2 One-fifth of propodeum basally and often laterally remarkably more finely sculptured than on declivous part, usually smooth shining or partly wrinkled, often impressed medially, declivous part mostly rugulose. 2–4 joints of fore and middle tarsi very short and broad (♂), also claws of middle tarsi assymmetric, specialized (♂). Frons with minute punctures and also with scattered larger punctures. Largely black species with light spots and streaks on tergites (*FULVIPES*-group) .. 3

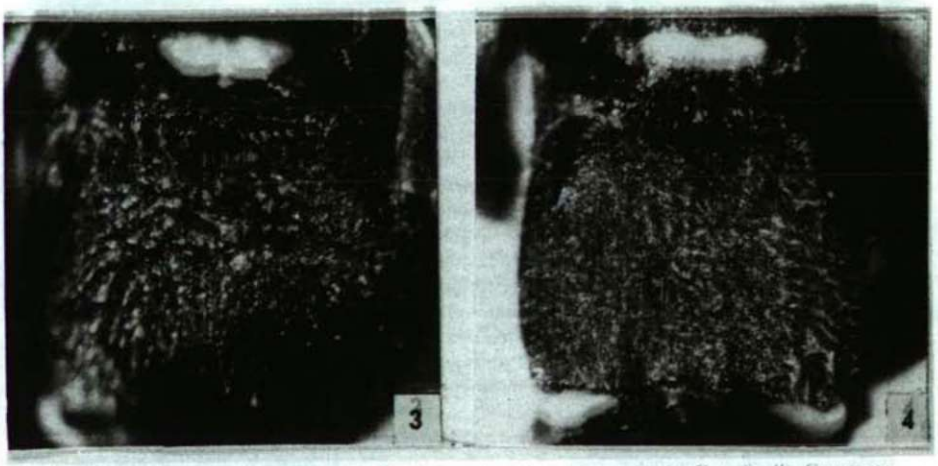
– Whole surface of propodeum mat, coarsely rugose (figs 1,3), posteriorly sometimes only rugulose or with irregular rough surface, laterally often strongly punctured. Tarsi and claws normal. Usually largely, nearly entirely yellow, partly ferruginous, rarely a more or less black species (*RUFICORNIS* group) 5

3 Frons hardly punctured, larger punctures separated from one another by a distance of about 4.0 times their diameter on the average; the same on mesonotum by an average of about 1.5 times their diamater (♀♂). Male hind coxa with a large, internal, basal, obliquely truncate lobe that substends a large excavated area basally of coxa. Subgenital plate produced and in profile swollen apically (♂). The whole of the lower face (♂) or part of the labrum yellowish white and supraclypeal area with a black spot medially (♀), usual spots on thorax and posterior bands on tergites, except tergite 1, that with two large triangular spots (♂) or sometimes interrupted (♀). Trochanters-tarsi yellowish red with some light spots. ♀ 6–8.3, ♂ 4.7–6.5 mm

fulvipes CRESSON



Figs. 1–2. *Ceropales saltoensis* sp.n., 1 = postscutellum, postnotum, propodeum and tergite 1; 2 = pronotum in lateral view.



Figs. 3–4. Postnotums and propodeums, 3 = *Ceropales tokyoensis* sp.n.; 4 = C. *ruficollis* CAMERON.

– Frons distinctly punctured, larger and deeper punctures on frons separated from one another by a distance of about 2.0 times their diameter on the average; the same on mesonotum by an average of about 0.7 times their diameter (♀♂). Male hind coxa at most with a long-shaped ditch inside, subgenital plate triangular in profile, not so swollen apically. Mandible largely (♀) or basally (♂) black. Lower face entirely (♂) or except the black spot on supraclypeal area, yellowish white (♀). Thorax with the usual light spots 4

4 Fore and middle femora yellowish red with larger, apical yellowish streaks on outer side. Male hind coxa not specialized; subgenital plate not swollen apically (♂). Labrum largely (♀) or entirely (♂) yellowish. Outer orbit with continuous streak, above mandible broader, from middle narrower

yellowish white streak. Tergite 1–5 with apical light bands, 1 sometimes interrupted medially, 6 with medial spot (♀) or 1(2)–5 with apical light bands or 1 with lateral and 6–7 with medial spots (♂). ♀ 6–8.3, ♂ 8–11.9 mm

brevicornis PATTON

– Fore and middle femora black or dark brown with ivory or yellowish white streaks apically. Male hind coxa with a rather deep, long-shaped ditch inside. Subgenital plate in profile somewhat swollen apically. Labrum entirely black (♀) or yellowish white (♂). The narrow ivory or yellowish white streak of outer orbit broadly interrupted into an upper and a lower half. Tergite 1 usually with lateral spots, 2–4 (♀) or 2–5 (♂) with whitish bands, 5–6 (♀) or 6–7 (♂) with medial spots. ♀ 5.5–6.5, ♂ 7–8.5 mm

neomexicana ROHWER

5 Basal part moderately bending into declivous part. Body black with more or less yellow spots and streaks, never ferruginous. Postnotum broader, nearly all coarse wrinkles running parallel and longitudinally.....6

– Basal part in one-fifth part of length of propodeum strongly broken towards the fourth-fifths declivous part. Body largely yellow, sometimes partly ferruginous. Postnotum narrow, coarse wrinkles running mostly transversally 7

6 Tergites 1–5 with broad pale yellow posterior bands. Lower face, except black mandibles, outer orbit, posterior and lateral margins, callus of pronotum (fig. 2), spot on tegulae, postscutellum, lateral corners of propodeum, large spots on coxae pale yellow, tibiae and tarsi ferruginous, tibiae with yellow streaks or spots. Wrinkles of propodeum running regularly and longitudinally at basis and transversally on declivous part (fig. 1). Antenna black, 1–2 joints with yellowish spots below. Frons mat. 10 mm

saltoensis sp.n. ♀

– Tergite 1 with large lateral, 6 with medial yellow spots, 2 with posterior yellow band laterally broader than medially. Lower face, including clypeus with broad longitudinal and black band; one-third of clypeus laterally, inner orbit, a narrow and short streak on outer orbit, posterior margin of pronotum, postscutellum, postero-lateral corners of propodeum, yellow. Face coriaceous, with scattered larger punctures. Pronotum, mesonotum and scutellum deeply and densely punctured. Propodeum with conspicuously coarse rough surface (fig.3), basally and laterally with irregular, partly transversal, in declivous part with longitudinal wrinkles. 6.5 mm

tokyoensis sp.n. ♀

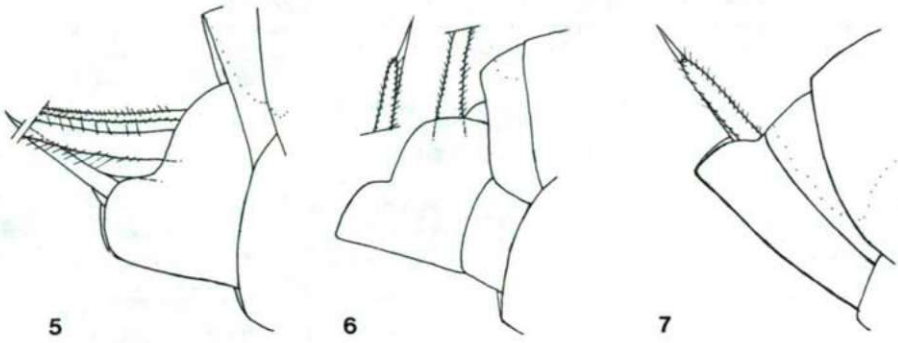
7 Vertex, antenna, occiput largely, mesonotum, propodeum and episternum largely or entirely,legs, tergites 1–3 basally ferruginous; black only round ocelli; lower face, frons between eyes and outer orbit broadly, pronotum entirely, tergula yellow; tergites 1–5 with broadly yellow bands, mesonotum, postscutellum, propodeum laterally and legs with yellow spots. Surface of mesonotum shining with deep and dense punctures. Propodeum longitudinally rugose basally and transversal rugose on declivous part, only slightly impressed medially. Frons scatteredly punctured. Wings yellowish infuscated. 7–8.8 mm

ornata SMITH

– Body largely yellow and black, legs yellow, partly ferruginous. Surface of mesonotum coriaceous, mat, with punctures. The large yellow spot extending between inner orbits from antennal socket nearly to lower ocellus, lower face, also mandible yellow (♀♂), with a black spot above antennal socket (♀). Propodeum coarse, longitudinally rugose basally, projecting or hamped more (♀) or less (♂) between spiracles and corners, declivous part concave (♀) or flat (♂). Lower edge of last sternites convexe basally slightly concave and arcuately truncate apically (♀) (fig. 7) ♀ 9.5–10.5, ♂ 6–8.4 mm

ruficornis GUSSAKOVSKIJ

8 Pronotum, propodeum black, tergite 1(2) often yellowish red, at most with light spots. Head, pronotum, mesonotum coriaceous, at most with moderate punctures, silky shining, at most with some shallow and fine larger punctures laterally and next to ocelli. Punctures of mesonotum shallower. Propodeum granulated with finer sculpture. Last sternites (♀) truncate apically (fig. 8) 9



Figs. 5–7. Last abdominal sternites, 5 = *Ceropales saltoensis* sp.n.; 6 = C. *tokyoensis* sp.n.; 7 = C. *ruficornis* GUSSAKOVSKIJ

– Pronotum largely, propodeum and tergite 1 often ferruginous, tergites usually with ivory or yellowish white bands. Head, pronotum, mesonotum dull granulated, mesonotum and episternum with scattered larger and deeper punctures superimposed. Propodeum hardly or anteriorly convex, at most excised to a small degree basally, rather coarser sculptured (fig. 4). Last sternites (♀) triangular apically (figs 9–10) 10

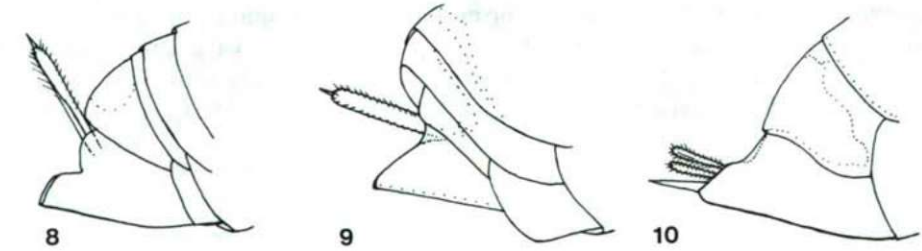
9 Tergites 1–2 yellowish red, 2 rarely only partly, tergite 2 with white lateral spots, 6 with medial- (♀) or with two white spots (♂), pronotum with two oblong white streaks. Postnotum with parallel sides. Mesonotum, episternum coriaceous, without punctures. Legs largely yellowish red, hind tibia blackish apically, spine yellowish red. Lower face white, with broad longitudinal black streak (♀♂). Flagellum entirely black. Last tarsal joint of middle legs yellowish red. Lower edge of last sternites convex basally and truncate apically (fig. 8) 3.5–7 mm

variegata SHUCKARD

– Abdomen black with ivory spots on tergite 1, 2–5 with narrow apical and medially interrupted bands, 7 with medial spot. Posterior white band of pronotum continuous, narrow, not reaching tegulae. Postnotum broadened medially in a slightly obtuse angle towards propodeum, surface finely cross wrinkled and interrupted by a deeper shiny line medially. Episternum moderately and sporadically punctured below tegulae. Mesonotum with scattered larger punctures. Femora 1–2 brownish, 3 rufous, hind tibia and tarsi entirely black, spine white. Lower face with inner orbit yellow, flagellum ferruginous below. Last tarsal joint of middle legs black. 4.5 mm

turcomana GUSSAKOVSKIJ ♂

10 Mandible, labrum, clypeus largely, antenna, except the black last 2–3(4) joints, inner and outer orbit continuously ferruginous, sometimes paler or partly yellowish; supraclypeal area black or



Figs. 8–10. Last abdominal sternites, 8 = *Ceropales variegata* (FABRICIUS), 9 = C. *picta* SHUCKARD, 10 = C. *ruficollis* CAMERON

brownish below antennae and often the black spot below or around tentorial pit. Often two or four longitudinal streaks on mesonotum, tegula, middle of scutellum, postnotum only laterally, nearly whole propodeum, legs nearly entirely and usually tergite 1 before white band, in more or less extent, ferruginous. Postscutellum with white spot. Tergites 2 or 2–4 black and dark reddish narrowly translucent, preapical band of tergite 1 broader, of 3–7 narrower yellowish white. Labrum 2.3–2.7 times broader than long. Interocular distance on vertex 1.4–1.5 times wider than the least distance between eyes below antennae. POL:OOL = 7–8:10–11. Last sternites triangular apically (fig. 9) ♀ 6–10, ♂ 6–8.5 mm

picta SHUCKARD

– At least sides of clypeus and supraclypeal area in a gradually narrowing line along inner eye margin up to sinus usually ivory white (♀♂), middle of lower face black (♀ partly ♂). Sometimes posterior half of propodeum laterally ferruginous. Antenna largely black or ferruginous. Labrum twice as wide as long. Postscultellum with white streak 11

11 Coxe, trochantres and greater part of femora black, tibiae tarsi largely ferruginous. Lower face with a broad longitudinal and black line medially (♀♂), sometimes entirely black at most with two small white spots on clypeus laterally (♀) or often entirely white (♂). Usually inner eye margin white and hardly ferruginous above, outer eye margin yellowish or brownish only narrowly. Labrum more or less black or yellowish white, lower margin brownish. Mandible largely black. Antenna black, anterior flagellar joints more or less ferruginous at least below. Preapical band of tergite 1 broadly white, 3–6(7) with a narrower bands or rarely abdomen entirely black. POL:OOL = 6:9. Thickened part on lateral corner of propodeum reaching not beyond middle of half posterior margin. ♀ 6, ♂ 5.2–7 mm

latifasciata ARNOLD

– Legs including underside of coxae largely, or at least partly ferruginous. Lower face with a broad longitudinal and black line medially (♀♂). Inner eye margin white, hardly ferruginous in emargination of eye (♀♂). Outer eye margin brownish and broad basally, narrowing about the middle and yellowish brown above. Labrum pale ferruginous (♀) or white with ferruginous lower margin (♂). Mandible black only on basal half. Antenna ferruginous, only last flagellar joints partly black. Tergites 1, 3–6(7) with white or yellowish white bands, 2 black with very dark red posterior margin. Tegula, sometimes a narrow longitudinal streak on mesonotum laterally ferruginous. POL:OOL = 8:10. Thickened edge of propodeum reaching beyond middle of its half posterior margin (fig. 4). Last sternites triangular apically (fig. 10). ♀ 8–9.1, ♂ 5.8–7 mm

ruficollis CAMERON

The *FULVIPES*-group

Frons shining or subshining with minute punctures and also with scattered larger punctures. Pronotum, mesonotum often deeper and denser punctured. Propodeum roundly curved on its one-fifth part basally, often impressed medially and flat on four-fifths declivous part posteriorly, smooth, shining or finely sculptured and subshining basally and laterally, rugulose posteriorly. Tarsi and claws normal (♀) or second to fourth joints of fore and middle tarsi very short and broad (♂), last joint of fore tarsus with a rounded swelling on front side (♂). Outer claw of fore leg with a large triangular lobelike, appressed basal tooth, inner claw with a median appressed lobelike tooth (♂). Outer claw of middle leg with a large lobelike tooth that is strongly appressed to the claw, inner claw with a large, erect, triangular, subapical tooth (♂). Last sternites compressed and with a projecting apical part, apex of which rounded (♀). Subgenital plate triangular, with an acute apical point (♂). Abdominal tergites with yellowish bands or spots.

This group includes the Nearctic *fulvipes*, *brevicornis* and *neomexicana*.

Ceropales fulvipes CRESSON

Ceropales fulvipes CRESSON, 1872, Trans.Am.ent.Soc. **4**:208 ♀
Ceropales fulvipes: 1892, FOX, Trans.Am.ent.Soc. **19**:49,50,52 ♀
(= *C. brevicornis* PATTON, 1879 ♂ as a syn.)
Ceropales fulvipes:1895, DALLA TORRE, Wien.ent.Ztg. **14**:91
Ceropales fulvipes:1897, DALLA TORRE, Cat.Hym.**8**.Fossor.: 342 ♀♂ (= *C. brevicornis* PATTON, 1879 ♂ as a syn.)
Ceropales fulvipes:1957, TOWNES, Bull.U.S.natn.Mus. **209**:237, 271 fig. 161 ♀♂
Ceropales fulvipes:1979, KROMBEIN, Cat.Hym.Am.N.Mex. **2**:1569 ♀

Specimens examined: 4 ♀ and 11 ♂. U.S.A. = Alaska: Cordova coll. de SAUSSURE 2 ♂ (Genève and Budapest); Texas: 1 ♀, 1 ♂ (Budapest), Fredericksburg 18 Apr 1959 W.R.M. MASSON 1 ♀, 1 ♂ (Ottawa), Kerville 4, 15, 16 Apr W.R.M. MASON and J.F. MCALPINE (swept ex *Aesoulus* sp.) 3 ♂ (Ottawa), 1 ♀, 2 ♂ (Budapest); and 22 Jan E. S. ROSS 1 ♂, as well as Uvalde Co. Speir Rch, 1 Mai 1977 Mal. trap T. EICHLIN M. WASBAUER 1 ♀ (Sacramento) N. Mexico: Gallup Mc Kinley Co. 6500 ft 21 Jul 1950 T. COHN 1♂ (New York).

Distribution. U.S.A. = Texas (CRESSON, 1872); Kansas, Montana (FOX, 1892); Alaska, North Mexico.

Ceropales brevicornis PATTON

Ceropales brevicornis PATTON, 1879, Bull.U.S.Geol.Surv.**5**:368 ♂
Ceropales brevicornis: 1957, TOWNES, Bull.U.S.natn.Mus. **209**:239, 268 fig. 159 ♀♂
Ceropales brevicornis: 1979, KROMBEIN, Cat.Hym.Am.N.Mex. **2**:1569 ♂

Specimens examined: 3 ♀, 4 ♂, U.S.A. = Colorado: 4 Mi.N.E.Idalia Yuma Co. 10. Aug 1964 J.G. and B.L. ROZEN 2 ♂ (New York and Budapest); Iowa: City Wickham 1 ♀ (Bruxelles), Sioux City 4 Aug 1922, 10 Sep 1930 C.N. AINSLIE 1 ♀, 1 ♂ (Budapest); Kansas: Riley County Aug 1 ♀, 1 ♂ (Budapest).

Distribution. U.S.A. = Kansas (PATTON, 1879); Luisiana, Texas, New Mexico north to Pennsylvania and Alberta, Rocky Mountains (TOWNES, 1957); Washington (KROMBEIN, 1979); Iowa.

Ceropales neomexicana ROHWER

Ceropales neomexicana ROHWER, 1915, Proc.U.S.natn.Mus. **49**:236 ♂
Ceropales neomexicana: 1957, TOWNES, Bull.U.S.natn.Mus. **209**:239, 270 fig. 160 ♀♂
Ceropales neomexicana: 1979, KROMBEIN, Cat.Hym.Am.N.Mex. **2**:1570 ♂

Specimens examined: 5 ♀, 7 ♂. U.S.A. = California: Fresno, San Joaquin 1–5 Jul 1984 2 ♂ (Sacramento) and 1 ♂ (Budapest); San Diego, Borego F.X. WILLIAMS 1 ♂ (Sacramento);Vig.gland. hairs of vs. on *Helianthus annuus* 26 May 1912 J.C. BRIDWELL 1 ♂ (Budapest); Nevada: Logandale 12 Aug 1959 F.D. PARKER 1 ♂ (Sacramento); New Mexico Hidalgo Co. 29 Jul 1959 on *Asclepias subverticillata* E.G. LINSLEY 1 ♀ and Aug 1978 on *Baccharis glutinosa* M.S. WASBAUER 1 ♂ (Sacramento) and 1 ♂ (Budapest); MC KINLEY Co. 19 mi.N. Gallup 14 Aug 1972 J.G. ROZEN and MC GINLEY 1 ♂ (New York). — Mexico = Souosap 4 Jul 1927 1 ♀ (Budapest); 16.mi. W. Durango Dgo 7200' 28 Jun 1964 J.F. MCALPINE 1 ♂ (Ottawa).

Distribution. Northern N. Mexico (ROHWER, 1915). U.S.A.: California, Arizona, New Mexico and Sonora (TOWNES, 1957).

The *RUFICORNIS*-group

Frons convex or hardly broken, moderately, mesonotum deeper and denser punctured. Propodeum strongly, rarely only moderately broken about on its one-fifth part basally and flat or concave on four-fifths declivous part when viewed from the side, and often punctured laterally. Surface of propodeum coarsely rugose, at least rugulose on its whole length or rather smooth, partly shining only basally. Hind claws rectangularly curved, tarsi and further claws normal with small subapical tooth (♀♂),except inner claw of fore leg, which deeply emarginate (♂). Last sternites compressed laterally and with a projecting apical part, apex of which above roundly, below rectangularly truncate, rarely rounded both above and below (♀). Subgenital plate flat, truncate posteriorly with rounded lateral corners (♂).

This group includes the species *saltoensis*, *tokyoensis*, *ornata* and *ruficornis*, sporadically known from the East Mediterranean, South–East Euro–Turanian and East Asian regions, as well as from East India fauna province and from Mexico.

Ceropales saltoensis sp.n.

Specimen examined: 1 ♀ holotype. Mexico: „3 mi.E.El Salto, Dgo, Mex. 8400' June 21, 1964 W.R.M. MASON" (deposited in Biosytematics Research Institute, Res.Branch, Ottawa, Canada), No. 19198(HT).

♀. — Length 10 mm. Black, lower face, inner and outer orbit, small spots on scape and pedicel in front, posterior, lateral margins and callus of pronotum, spot on tegula and basis of fore wing, postscutellum largely, postero-lateral spots on propodeum, posterior broad bands on tergites 1–5, underside of fore coxa, apical half of middle coxa, large spot apically and a line outside on hind coxa, small spots outside on fore and middle femora, on middle and hind tibiae, fore tibia in front, pale yellow; rest of tarsi ferruginous, except the last tarsal joints apically. Wings brownish infuscated, veins brown, pterostigma brown. Frons hardly broken below fore ocellus, surface finely granulate, mat, with scattered and shallow punctures, frontal sulcus distinct only above antennae. Ocelli in a distinct obtuse angle, POL:OOL = 9:12. Pronotum, mesonotum largely with deeper and denser punctures, pronotum between the yellow margin of lateral side and callus more or less diagonally wrinkled (fig. 2). Postnotum hardly broader medially than laterally, with stronger and parallel longitudinal wrinkles (fig. 1). Basal part of propodeum moderately bending into declivous part, with rather strong wrinkles, these running longitudinally at basis and transversally on declivous part, then again longitudinally on lateral side, lower half of lateral side of propodeum coriaceous, with scattered shallow punctures. Episternum with deeper, but only on ventral side denser punctures. Claws normal. Abdomen finely reticulated only moderately shining. Last sternites compressed laterally and with a short projecting apical part, apex of which rounded both above and below, viewed from the side (fig. 5).

Ceropales tokyoensis sp.n.

Specimen examined: 1 ♀ holotype. Japan: „Chichibu, Saitama Pref.near Tokyo", „1913 X.16" Type No. 2561 (deposited in Kyushu University, Entomological Laboratory, Faculty of Agriculture, Fukuoka, Japan).

♀. — Length 6.5 mm. Black, inner eye margins, lateral one-third part of clypeus, a small and narrow streak on outer eye margin above, two minute spots on tubercle between antennae, a longitudinal streak on underside of scape, posterior margin of pronotum including the lateral corners below tegulae, callus of pronotum, postscutellum, postero-lateral corners of propodeum, two large spots on tergite 1 laterally, posterior band of tergite 2 laterally broader, medially narrower, a spot on tergite 6 medially, spot on underside of fore coxa, small spot on middle coxa apically, outer edge narrowly of hind coxa, yellow, femora apically and tibia basally and apically, underside of hind tibia largely, spurs and tarsi partly yellowish brown. Wings brownish infuscated, nervature similar to *C. m. maculata* (FABRICIUS). Head and thorax covered partly with fine silky toment.

Front subshining, coriaceous, with very small punctures and with scattered larger punctures separated from each another by about 2 to 3 times their diameter; ocelli in a rectangle, POL:OOL = 7:9; pedicel half as long as antennal joints 3, 3 as long as 4, or as long as scape; frontal sulcus distinct medially, frons hardly concave above antennae and slightly broken below fore ocellus, viewed from the side. Pronotum, mesonotum and scutellum densely and deeply punctured, interspaces mostly narrower than punctures. Postnotum with coarse longitudinal wrinkles, hardly impressed medially. Propodeum conspicously rugose (fig. 3), the deep wrinkles irregular basally, running transversally below spiracles and rather longitudinally in the flat declivous part. Episternum densely but less deeply punctured than mesonotum. Lateral side of propodeum strongly wrinkled only medially, coriaceous partly and moderate shining. Hind coxae flattened inside. Abdomen polished, very finely reticulated. Last sternites compressed laterally, underside straight with apex above roundly, below nearly rectangularly truncate (fig. 6). Claws normal, with small subapical tooth, hind claws rectangularly curved.

Ceropales ornata SMITH

Ceropales ornata SMITH, 1855, Cat.Hym.Brit.Mus.**3**:179 nr.7 ♀
Ceropales ornata: 1891, CAMERON,Mem Proc.Manchr lit.phil.Soc.: 434
Ceropales ornata: 1892, FOX, Trans.Am.ent.Soc.**19**:62
Ceropales ornata: 1895, DALLA TORRE, Wien.ent.Ztg.**14**:92
Ceropales ornatus: 1897, DALLA TORRE, Cat.Hym.8.Fossor.:344 ♀
Ceropales ornata: 1897, BINGHAM, Fauna Brit.India Ceylon Burma I:174

Specimens examined: 2 ♀, 1 ♂. India: „Ind." 1 ♀ lectotype and 1 ♂ paralectotype (Oxford); „Nasik", „Bombay Presidency, pres. by E. COMBER. 1910–255.", „Type WWS coll Oxford det M.C. DAY 198 " WWS = W.W. SAUNDERS, „*C.ornata* Sm. det. M.C. DAY 198 " 1 ♀ (London).

No exact type locality was given by the author, only „Hab. India" and it was referred to „in other examples", consequently these above listed specimens can be regarded as the original material. As the writing, the form of the label, also the pin and the mounting of the specimens (Ind.) are the same as SMITH's other types, e.g. on *Ceropales flavopicta* SMITH. I designate as lectotype the female and as paralectotype the male with labels „Ind." (Oxford).

SMITH's short diagnosis can be supplemented as follows. Lenght ♀ 7.8 (lectotype) — 8.8 mm, ♂ 7 mm. The dark spots extending larger on male than on female and reduced on other female (Nasik); basis of tergites 2–5 dark rufous black (♂); all the rest corresponding to those of the female. Frons convex between fore ocellus and antennae, viewed from the side. Propodeum rather strongly broken basally, declivous part flat, transversal rugulose. Subgenital plate long triangular pointed, with rather straight sides, broadly rounded with a sharp and long excision distally (♂). Claws normal, fore and middle claws with minute subapical tooth.

Distribution. India (SMITH, 1855).

Ceropales ruficornis GUSSAKOVSKIJ

Ceropales ruficornis GUSSAKOVSKIJ, 1931, Ezheg.zool.Mus.**32**:4, 2 ♀♂
Ceropales gilvus HAUPT, 1962, Bull.Res.Coun.Israel **11B**:32 ♀♂ syn.nov.
Ceropales gilvus: 1966, PRIESNER, Israel J.Ent.**1**:151,152 ♂
Ceropales ruficornis gilvus: 1978, MÓCZÁR, Acta biol.Szeged. **24** : 126 fig. 5 ♀♂ stat.nov.

Specimens examined: 7 ♀, 9 ♂. Azerbaidzhan SSR: Kuru–tshaj 2 Jun 1927 GUSSAKOVSKIJ 1 ♂ paralectotype (Hym. Typ. No. 3645 Budapest). — Turkmen SSR: Iman-baba 1932 SHESTAKOV 1 ♂ (Budapest). — Israel: „Jerusalem, Palestine 1.VI.1940 BYTINSKI–SALZ", „Holotype" and „Type" red labels, „*Ceropales gilvus* HAUPT ♀ HAUPT det 1952" with HAUPT's writing 1 ♀ holotype (Tel Aviv); „Jericho, Palestine 11.6.1941 BYTINSKI–SALZ", „Allotype", „Typus" red labels, „*Ceropales gilvus* HAUPT ♂ HAUPT det 1952" 1 ♂ paratype (Tel Aviv); „Jerusalem Palestine 12.6.1941. BYTINSKI–SALZ", „*Ceropales gilvus* HAUPT ♀ HAUPT det 1952", 2 ♀ paratypes (Tel Aviv and Hym. Typ. No. 3646 Budapest); „Palestine Urim 3.6.19 leg. BYTINSKI–SALZ", „Paratypus ex coll. BYTINSKI–SALZ", „*Ceropales gilvus* HAUPT ♀ HAUPT det 1953" with HAUPT's writing, 1 ♀ paratype (Tel Aviv); Palestine Urim 15 May 19 BYTINSKI–SALZ 1 ♂ (Tel Aviv); Adulam 26 Aug 1970 BYTINSKI 1 ♂ (Tel Aviv) and 1 ♀, 1 ♂ (Budapest); Sarafand 28 Apr BYTINSKI–SALZ 1 ♀ (Tel Aviv); Hulda 1966 KUGLER 1 ♂ (Tel Aviv). — Cyprus: Zakaki Jul, Aug 1 ♀ 1 ♂ (Budapest). — Syria: Mezzé, near Damascus 27 May 1955 A. MOCHI 1 ♂ (Coll. MOCHI). — Jordania: Jericho (= El Riha) SCHMIEDEKNECHT 1 ♀, 1 ♂ (Frankfurt/M. and Budapest).

The *gilvus* specimens of the original material designated by the author and the other specimens, are remarkable differently coloured even in the same locality (Adulam). Body nearly entirely yellow, black only between the large yellow spots on vertex, occiput, median sternite of thorax, basis of segment 1 and of tergites narrowly or the yellow colouring distinctly retired, e.g.tergites black, 1 only with two large yellow spots laterally, the others with posterior yellow bands. Sculpturally difference less conspicuous, rugosity of basis of propodeum less pregnant on smaller specimens or wrinkles running partly longitudinally and diagonally, partly longitudinally on basis. Genitalia of *gilvus* corresponding to that of *ruficornis*. Also the slightly concave lower edge before the tip and the arcuately truncate end of the last sternites (fig. 7) of the two species agree with each other.

Distribution. Russian (Asia), Azerbaidzhan SSR (GUSSAKOVSKIJ, 1931). Turkmen SSR, Cyprus, Palestine (MÓCZÁR, 1978). Israel, Syria, Jordania.

The *VARIEGATA*-group

Frons convex, at most rarely slightly broken. Head, mesonotum, propodeum coriaceous-granulated, mat, hardly punctured not shining. Eyes less reniform, sinus on inner eye margin being shallow. Scutellum more or less gibbous, postscutellum normal, not raised. Postnotum with nearly parallel margins, at most slightly impressed posteriorly in middle. Propodeum moderately convex on anterior part or on its whole length. Propodeum without longitudinal sulcus basally, at most excised to a small degree. Claws normal. Body usually partly ferruginous or yellowish red. Last sternites compressed and with projecting apical part, apex of which above rounded and below pointed (♀)(fig. 8). Subgenital plate truncate apically and emarginate or deeply excised medially (♂). Tergite 2 or 3–6 usually black.

This group includes the species *variegata*, *turcomana*, *picta*, *latifasciata* and *ruficollis*, widely distributed in the Palearctic and the Ethiopian fauna regions.

Ceropales variegata (FABRICIUS)

Evania variegata FABRICIUS, 1798, Suppl.ent.System.:241
Ceropales De Stefanii COSTA (sic), 1887, Prosp.Imen.Ital.**2**:48 ♂ T.1 fig. 14 ♀ (!)
Ceropales Destefanii: 1892, FOX, Trans.Am.ent.Soc.**19**:61
Ceropales variegata: 1892, FOX, Trans.Am.ent.Soc.**19**: 63
Ceropales Destefanii: 1895, DALLA TORRE, Wien.ent.Ztg.**14**:91
Ceropales variegata: 1895, DALLA TORRE, Wien.ent.Ztg.**14**:92
Ceropales Destefanii: 1897, DALLA TORRE, Cat.Hym.8.Fossor.:342 ♂
Ceropales variegatus: 1897, DALLA TORRE, Cat.Hym.8.Fossor.:345 ♀♂ (var.*obscurus* and var.*notatus* TOURNIER, 1889)
Ceropales variegatus: 1927, HAUPT, Dt.ent.Z.(Beih.): 296, 299 ♀♂
Ceropales destefanii: 1927, HAUPT, Dt.ent.Z.(Beih.): 296, 300
Ceropales variegata: 1931, GUSSAKOVSKIJ, Ezheg.zool.Mus.**32**:4, 15 ♀♂
Ceropales variegatus: 1938, HAUPT, Ark.Zool.**30A**:11 ♀♂
Ceropales impunctatus YASUMATSU, 1939, Trans.Kansai ent.Soc.**9**: 9 fig. 1 ♀ syn.nov.
Ceropales destefanii: 1947, BEAUMONT, Mitt.schweiz.ent.Ges.**20**: 517 ♀♂ as syn. of *C.variegatus* (FABRICIUS)
Ceropales variegatus: 1947, BEAUMONT, Mitt.schweiz.ent.Ges.**20**: 517 fig. 6, 17 ♀♂
Ceropales variegatus: 1954, MÓCZÁR, Folia ent. Hung. (S.n.) **7**: 149, on *Euph. gerardiana*
Ceropales variegatus: 1955, WAHIS, Bull.Inst.r.Sci.nat.Belg.**31**:8
Ceropales variegatus: 1956, MÓCZÁR, Fauna Hung. **13(5)**:76 ♀♂
Ceropales (Ceropales) variegatus: 1965, WOLF, Nachr.naturw.Mus. Aschaffenb. **72**: 38 ♀♂
Ceropales variegatus: 1969, WOLF, Opusc.ent. **34**:14
Ceropales (Ceropales s.str.) *variegatus*: 1969, PRIESNER, Naturkundliches J.Stadt Linz: 115, 118 ♀♂
Ceropales variegatus: 1970, WOLF and DINIZ, Mem. Estud.Mus.zool.Univ.Coimbra No 311:19
Ceropales variegatus: 1971, WOLF, Acta faun.ent.Mus.natn.Pragae (Suppl. 3): 59 ♀♂
Ceropales (Ceropales) variegatus: 1972, WOLF, Ins.Helv.Fauna 5 Hym.: 166, 168 fig. 476 ♀♂
Ceropales variegatus: 1978, MÓCZÁR, Acta biol.Szeged.**24**:116 ♀♂
Ceropales variegatus: 1979, WAHIS, Bull.Rech.Agron.Gembloux **14(2)**: 192 ♀♂ on *Angelica*
Ceropales variegata: 1979, DAY, Bull.Br.Mus.nat.Hist.**38**: 20 ♂
Ceropales (Ceropales) variegata: 1986, WAHIS, Notes faun.Gembloux **12**: 35

Specimens examined: 13 ♀, 17♂.GDR: „Type" red label, „Halle Hübner", „*Ceropales variegata* HB.F FAB. type collect. (Hübneri) Germar", „Lecto-Holotypus" H. WOLF det. 1983", „*Ceropales variegatus* (FABR.)♀ H. WOLF det 1983" (abdomen missing) 1 ♀ paratype; and a male with the same labels except the third and instead of „Lecto-Holotypus" a „Lecto-Allotypus", 1 ♂ paratype (Berlin). — Italy: „T. De-Stefani Sicilia", „*Ceropales De-Stefanii* ♂ COSTA" paralectotypes: 1 ♂ and with the same data of the first label 1 ♂ (Berlin). — China: „(Manchuria) 1.VII.1937 Hsinking, Z. OONO", „Holotype *Ceropales impunctatus* YASUMATSU 1939" with YASUMATSU's writing, 1 ♀ holotype (Fukuoka). — See MÓCZÁR (1978:116). — Spain: Salamanca, Parada de Rubiales 24 Jun 1961 J.v.D.VECHT on *Thapsia villosa* L. 1 ♀ (Leiden). — France: Hte Savoie 18 Aug 1929 J. DE BEAUMONT 1 ♂ (Lausanne). — Switzerland: Genève, Allondon 8. Aug 1935, Cologny 1–9 Aug 1946 J. DE BEAUMONT 2 ♀ (Lausanne); Martigny 20, 27 Aug, 4 Sep 1932 2 ♀ 3 ♂, 23 Jul 1935 3 ♂, 29 Jun 1936 1 ♂ J. DE BEAUMONT (Lausanne); Lavais les Follateres 9 Aug 1965 P. BOVEY 1 ♂ (Lausanne); Neuveville 1 ♀ (Lausanne). — Hungary: Ladányhalászi 28 Aug 1957 2 ♀, 1 ♂ and Kisgéc 14, 24 Aug 1957 LIPTHAY 1 ♀, 1 ♂, Sátor hgys. 21 Jul 1957 RÁCZ 1 ♀, Szentgyörgyhegy 2 Sep 1958 F. MIHÁLYI 1 ♀, Bükk hgys. 1 Jul 1957 TÓTH S. 1 ♂ and Siklós 29 Jun 1955 GLASER M. 1 ♂ (Budapest). — Rumania: Transylvania, Cluj 8 Jun 1963 C. NAGY 1 ♂ (Budapest). — Turkey: Bilecik 27 May 1964 J. GUSENLEITNER 1 ♂ (Coll.GUSENLEITNER). — Israel: Kirj Gat 25 Apr 1970 Bytinski-Salz 1 ♂ (Tel Aviv).

DAY (1979) examined the holotype (♂) of *Evania variegata* FABRICIUS, for this reason the further specimens with the original data (Halle Hübner , Type-label) can represent the paratypes of variegata.

BEAUMONT (1947) designated the lectotype of *C. destefanii* from the 4 ♂ of COSTA's collection and synonymized it with variegatus. The 2 males preserved in Berlin and very probably from the same original material are designate now as paralectotypes. The light spots on one of the latter paralectotype distinctly reduced, on pronotum hardly discernible and only the hind legs partly reddish, fore and middle legs largely brown. On the other paralectotype the pronotal white streaks distinct, also legs largely yellowish red and only with minute basal spot white medially, similarly to the specimen originating from Habarovsk (East Siberia).

The holotype of *impunctatus* differs from *variegata* according to YASUMATSU in its reduced coloration, in the nervulus being oblique and POL shorter than OOL. The pronotal lateral streaks truly lacking, but spot of postscutellum and of tergite 2, 6 present, but hardly discernible, only transparent similarly to specimens e.g. from Switzerland or from some of Hungary. The characters of wing venation often vary. The relation of POL:OOL on *impunctata* is 5:6.5, on *variegata* 7–7.5:8. Head 1.06 times (*impunctata*), 1.15 — 1.19 times (*variegata*) broader than long, measured from vertex to lower margin of clypeus. These small differences are not significant enough to represent a bona species.

Tergite 2 black partly (var. *notata* TOURNIER, 1889) or postscutellum black (var. *obscura* TOURNIER, 1889), but often also legs partly black.

Distribution. Sibiria meridionali usque ad oceanum Pacificum (GUSSAKOVSKIJ, 1931). Austria (PRIESNER 1969). S.Sweden, S.England, E.Europe, Spain, Italy, Switzerland, Germany, Czecho-Slovakia, Hungary, Rumania, Yugoslavia, Greece, Morocco, Algeria, Russian SSR to Sibiria, Georgian SSR (WOLF, 1971), Turkey, Israel and China.

Ceropales turcomana GUSSAKOVSKIJ

Ceropales turcomana GUSSAKOVSKIJ, 1926, Ent.Oboz. **20**:251 ♂
Ceropales turcomana: 1931, GUSSAKOVSKIJ, Ezheg.zool.Mus.**32**:4,14 ♂
Ceropales turcomana: 1978, MÓCZÁR, Acta biol.Szeged.**24**:117 figs 6–7 ♂
Specimen examined: Turkmen SSR: Kopet–Dag 29–30 Apr 1888 A.P. SEMENOV, 1 ♂ holotype (Leningrad).

Distribution. Turkmen SSR (GUSSAKOVSKIJ, 1926).

Ceropales picta SHUCKARD

Ceropales picta SHUCKARD, 1837, Trans.ent.Soc.London **2**:70 ♀
Ceropales picta: 1885, SMITH, Cat.Hym.Brit.Mus.**3**:179 ♀
Ceropales picta: 1892, FOX, Trans.Am.ent.Soc. **19**:62
Ceropales picta: 1895, DALLA TORRE, Wien.ent.Ztg. **14**:92
Ceropales pictus: 1897, DALLA TORRE, Cat.Hym.8.Fossor.: 345 ♀
Ceropales pictus: 1912, TURNER, Ann.Mag.nat.Hist.**10**:361 ♀
Ceropales ruficollis CAMERON, 1910 sensu TURNER, 1912, Ann.Mag.nat.Hist.**10**:361 ♀
Ceropales pictus: 1937, ARNOLD, Ann.Transv.Mus. **19**:83,89 ♀♂
Ceropales ruficollis CAMERON, sensu ARNOLD, 1937, Ann.Transv.Mus. **19**:89 ♀ syn. nov.
Ceropales latifasciatus montivagus ARNOLD, 1955, Occ.Pap.natn. Mus.SthRhod.**20**:748 fig.15 ♀♂ syn. nov.
Specimens examined: 24 ♀,12 ♂. Rep.S.Africa: „*picta* SKD.", „Type", „*Ceropales picta* SHK. C.G.Hope (Type)", „type F.Sm.Coll. 79.22", „B.M.Type Hym. 19.783", 1 ♂ holotype (London); Cap.d. guten Hoffnung LICHTENSTEIN, Festiva N. (*picta* SHUCKARD Tr. Ent.Soc.II.70), 1 ♀ (Berlin); „Mamathes Basutoland 18–XI–1951 C.JACOT GUILLARMOD", „Type ♀ *Ceropales latifasciatus* r.*montivagus* G. ARNOLD" red label, 1 ♀ holotype (Cape Town); „Tebetebeng Mill. Basutoland 13–XI–1948 J.JACOT–GUILLARMOD", „Allotype *Ceropales latifasciatus* r.*montivagus* G.ARNOLD" red label, 1 ♂ paratype (Cape Town); further paratypes of montivaga:„Mamathes Basutoland 26–XII–1951 C.JACOT GUILLARMOD", „on *Calpurnia intrusa* (head lacking) 1 ♀ (Cape Town); „Hensley's Dam, Leribe, Basutoland 6–1–1948 C. JACOT–GUILLARMOD" 2 ♀ (Cape Town and Hym.Typ.No. 3646 Hung.Nat.Hist.Mus. Budapest), the same data but „29–II–1948", 1 ♀ and 1 ♂ (strongly gnawed off by *Anthrenus*) and all 5 specimens still with labels: „South African Museum ex National Museum Bulawayo 1981" and „*C.latifasciatus* v.*jucundus* r.*montivagus*" (Cape Town); Cape Prov. Katberg 15–30 Jan 1 ♀, 1 ♂ and Feb.1933 4 ♀ (Cape Town), 1 ♀ (Budapest); Aliwal North Dec 1922 1 ♀, 1 ♂ (London), Somerset East 31 Dec 1930 (the all collected by R.E.TURNER) 1 ♀ (Budapest); Estowe, Marley 1 ♀ (Cape Town); Steynsburg Div. 1 ♂ (Budapest); Buffalo River, Ladismith Div. 1 ♀ (Cape Town); Johannesburg 6000 ft 12 1898 J.P.CREGOE 1 ♀ (Budapest); Natal, Drakensberg Dec 1926 R.E.TURNER 1 ♀ (London) and 1 ♂ (Budapest), Umlazi Oct 1978 and Jan 1979 MILLER 2 ♀ (London); Pietermaritzburg 26 Oct 1978 Ngome Forest, 1–3 Nov 1970 H. and M. TOWNES 1 ♀, 3♂ (Coll. TOWNES) and 1 ♂ (Budapest); Wellington C.P. Rooshoek Jan 1960 A.M. VERHOEFF 2 ♀, 1 ♂ (Leiden) and 1 ♀, 1 ♂ (Budapest). — Zaire: Elisabetville 25 Apr 1929 M. BEQUERT 1 ♂ and DE LOOSE 1 ♀ (Tervuren).

According to SHUCKARD's diagnosis the description to this species was based on the female collected in „Cape of Good Hope", but the specimen proved to be a male, unfortunately the head is missing, notwithstanding it can be possible that this specimen represents the holotype. Therefore the character of the female are given on the basis of the specimen with the same locality conserved in Berlin. Naturally there are some differences between the SHUCKARD's description and the female, e.g.scutellum largely black, propodeum partly darker, the colour of orbits and clypeus (see in key),etc.

Concerning *C.latifasciatus montivagus*, ARNOLD labelled the first enumerated female (Mamathes, Basutoland 18–XI–1951) as a type in his diagnosis, so this female can be regarded as holotype and the further listed specimens as paratypes. From the original material I had opportunity to examine the „Allotype" from Basutoland, as well as further paratypes from Leribe. On the basis of these females and males the separation of the ssp. *montivaga* from the form *latifasciata* is easy, but I could not distinguish *montivaga* and *picta* satisfactorily from one another. The characters indicate the transitional forms between *picta* and *montivaga* as follows.

1.Inner eye margin uniformly ferruginous
2.Inner eye margin only pale ferruginous
3.Inner eye partly ferruginous, just along eye yellow
4.Inner eye yellowish white, clypeus pale ferruginous
5.Lateral angles of clypeus with black spot
6.Clypeus uniform, without black spots
7.Tergite 1 partly ferruginous
8.Tergite 2 not ferruginous
9. " 2 black (at most dark reddish translucent posteriorly)
10.Tergites 2–3 black
11.Tergites 2–4 black

		1	2	3	4	5	6	7	8	9	10	
picta ♀,	Cap d.g.Hoffn.	+				+		+		+		
"	Aliwal	+				+	+			+		
"	Katberg		+				+	+		+		
"	Somerset East		+				+	+			+	
"	Johannesburg			+			+	+		+		
"	Drakensberg	+					+		+	+		
"	Natal 1978	+				±			+	+		
"	Natal 1979	+					+		+	+		
"	Wellington	+				+		+		+		
"	"	+				±		+		+		
"	"			±			+	+		+		
picta ♂,	Drakensberg				+		+		+	+		
"	holotype							+	+	+		
"	Katberg			+		+		±			+	
"	Aliwal		+		+			+		+		
"	Wellington			+		+		±		+		
"	"		+			+			+	+		
motivaga ♀,	holotype			+			+	+		+		
motivaga ♂,	Tebetebeng		+			±		±				+
"	Mamathes	?				?		+			+	
"	*jucund.*.Leribe			+			+		+		+	
"	"			+			+	+			+	
"	"			+			+	+			+	

On the basis of this colouring variation and also because of the identity of the details of the male genitalia in both species, I regard the ssp.*monivaga* as a syno ym of *picta*.

Distribution. Cape Colony (SHUCKARD, 1837). Brit. East Africa, Ethiopia (TURNER, 1912). Zaire, Rep. of South Africa.

Ceropales latifasciata ARNOLD

Ceropales latifasciatus ARNOLD, 1937, Ann.Transv.Mus. **19**:83,92 figs 59, 59a–e ♀♂
Ceropales latifasciatus: 1951, ARNOLD, Bull.Br.Mus.nat.Hist. **2**: 183 ♂

Specimens examined: 4 ♀, 15 ♂. Ethiopia: „Abyssinia. (R.E. TURNER.) 1911–459", „Type *Ceropales latifasciatus* G.ARNOLD" red label, „B.M.Type Hym.19.785a" 1 ♀ and the same data and labels, except the ♀ and No. with ♂ and the No. 19.785b, paralectotype (London); Cencia Apr 1948 and Le Kempti 6500 ft 25 May 1946 K.M. GUICHARD 2 ♂ (Cape Town and London); Asmara 1 ♀, 1 ♂ (Budapest); Addis Abeba, Filoualia Jun 1941 PATRIZI 1 ♂ (Budapest). — Zaire: Tschiaberimu, Hintumo 2450 m 12 Mar 1953 1 ♂, Mt Kitwa 2840 m 29 Aug — 7 Sep 1953 1 ♂ and riv. Kalivina Talia Nord 2340–2350 m 28–29 Mar 1954 P.VANSCHUYTBROECK, H.SYNAVE and V.HENDRICK 1 ♀, 2 ♂ (Tervuren), 1 ♀, 1 ♂ (Budapest); SL Edouard–Katakunda Park Nat.Albert 5 Mar 1936 L. LIPPENS 3 ♂ (Tervuren); Ruanda, Machembe 1400 m terr.Nyanza 13–15 Jan 1953 P.BASILEWSKY 1 ♂ (Budapest); Massif Ruvenzori Kalonge 1840 m riv. Butahu P.VANSCHUYTBROECK 1 ♂ (Tervuren).

From the original material I designate the ♀ as lectotype and the ♂ as paralectotype from „Abyssinia". ARNOLD's diagnosis can be corrected as follows. Labrum shorter than half width (12:27 on lectotype), not „half as wide again at the base as long"; OOL:POL = 9:6 (lectotype), posterior ocelli not „half as far again from the eyes as from each other"; the interocular distance on the vertex 22: below antennae 15, not „nearly half as long again as the least distance between the eyes below the antennae" (♂).

Distribution. Ethiopia (ARNOLD, 1937).

Ceropales ruficollis CAMERON ♂ **nov.**

Ceropales ruficollis CAMERON, 1910, Wiss.Ergebn.schwed.Exp. Kilimandj.**2**:260 ♀
Ceropales latifasciatus var. *jucundus* ARNOLD, 1950, Occ.Pap. natn.Mus.Sth.Rhod. **2**:401 ♀ syn.nov.

Specimens examined: 5 ♀,5 ♂. Tanzania:„Kilimandj. SJÖSTEDT", „Kibonoto kulturz.", „7 maj" 1 ♀ lectotype and „Kilimandj. SJÖSTEDT", „Kibonoto 1300–1900 m", „maj", „*Ceropales ruficollis* CAM. Type" with CAMERON's writing, 1 ♂ paralectotype (Stockholm); Kilimandjaro, T.T. West side 8600 ft 26.XI.48 G Salt", „Camp.I. Shira. on ground in early sunshine", „Type *Ceropales latifasciatus* v. *jucundus* G.ARNOLD" red label, 1 ♀ holotype (Cape Town); Moschi Fl Rau Aug 1904 and Jul 1905, Africa or. KATONA 1 ♀ and 1 ♂ (**nov.**) (Budapest); Inter Marti et Arusha, Africa or KATONA 1 ♂ (Budapest); D.O. Afrika Kilimandscharo 3000–4000 m Jan 1906 SCHRÖDER S. 1 ♂ (Berlin); Expedt. Chyulu Hills July 1938 Alt. 5600 1 ♂ (London). – Kenia: 15 mls N.E. Kisumu (nr. Lake Victoria) Nov 1979 M.D. CROFT 1 ♀ (Budapest); Naivasha 19 Feb 1940 H.J.A. TURNER 1 ♀ (London).

In CAMERON's original material there are two specimens (♀♂) and only the male bears CAMERON's type label, whereas the female was mentioned in the diagnosis. Cameron had seen both specimens, therefore the locality also contains the data of the female („kulturz."). CAMERON evidently had misregarded the small sexual dimorphism so put erroneously the new name on the male. The description agrees with both specimens, therefore I designate the female as lectotype and the male as paralectotype.

ARNOLD (1937) synonymized *ruficollis* CAMERON with *C. picta* SHUCKARD. On the basis of the three types (*picta*, *ruficollis* and *latifasciata* var. *jucunda*) as well as on the basis of the unambiguously morphological and the colouring identity of

jucunda and *ruficollis*, *jucunda* is a synonym of *ruficollis*, differencies from *picta* being given in key.

♂. — Lenght 6–7 mm. Very similar to female, differing from it as follows. Basal black spot on mandible larger than on female. Labrum yellowish white, at most lower margin pale ferruginous. Only the last antennal joints black, the last 2 and 3 only above, underside ferruginous, similar to the further joints. Pronotum entirely reddish ferruginous. Propodeum (fig.4) with smaller or larger (paralectotype) pale ferruginous spots. Postscutellum and thickened edge of propodeum as on female. POL:OOL = 6:9. Seventh sternite broadly ovate, hollowed out on ventral surface, apex truncate.

Distribution. Tanzania (CAMERON, 1910). Kenia.

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CHECK LIST OF *COLLEMBOLA* ON A SANDY GRASSLAND (KISKUNSÁG NATIONAL PARK, HUNGARY)

E. H. HORNUNG

(Received: Sept. 15, 1985)

Abstract

13 species belonging to 4 families of the taxon Collembola were stated in the material of Barber traps filled with ethylene-glykoll. The traps were set in Bugacpuszta (KNP, Hungary), on the research area of the Zoological Institute of Szeged University. The number of individuals was between 60–80 thousand per year. There were both euedafic and epedafic species among them. The occurrence of *Onychoiurus armatus* (TULLB.) GISIN means pecularity for the investigated extrem dry sandy soil. The presence of *Cyphoderus albinus* NICOLET is also rarity. This was found in the nest of the ant *Lasius alienus* FÖRSTER.

The dominant species were: *Entomobrya nigriventris* STACH. (57.19%), *Entomobrya quinquelineata* BÖRN. (19.86%) and *Seira pallipes* REUTER (16.31%).

Key words: *Collembola*, check list, sandy grassland, dominance-ratio.

Introduction

The knowledge of the specific representatives of the investigated systematic or ecological group is fundamentally necessary to all ecological studies. Can it be either structural or funtional one. This means — as first step — the preparation of a check list. This was done at the beginning of the investigation of *Collembola* group as an important factor of decomposing subsystem in the frame of studies at Bugacpuszta (Kiskunság National Park) coordinated by the Zoological Department of the Attila József University at Szeged.

An account on the role of *Collembola* and on their population characteristics will be given in the next publication. Here and now presumably a full list of species is published.

The investigation of *Collembolas* living on the above mentioned area was started by HORVÁTH and NACSA (1982). They found 7 species determining 10355 specimens. The underestimation the number of species can be due to the samples consisting of relatively few specimens.

The description of abiotic and biotic factors of the area under discussion can be found in several publications (MÓCZÁR et al. 1980; KÖRMÖCZI et al. 1981; GALLÉ et al. 1985). The most important factors in the respect of *Collembolas* are: extremly dry, in summer often drought-dangerous climate, sandy soil featured by wind hollows and having mosaic vegetation and microclimate. These all determine the existence of *Collembola* and influence their seasonal dynamism.

Methods and discussion

The determined specimens were produced by the continuously active Barber-traps containing ethylene-glycoll arranged in fives, at 18 points of the area differing in their facilities.

The specimens were determined on the ground of GISIN's key (1960). The material yielded 13 species belonging to 4 families and they are representing both lifetypes:

epedafic (atmobiotic) = EE (here)
euedafic (hemiedafic, euedafic) = EU.

By the classification of EISENBEIS and WICHARD (1985) resp. that of GISIN (1943) in brackets.

The material studied consisted of about 60–80 thousand specimens per year. All the species could be found in the time whole of investigation (from March till December).

The list of the species:

fam.: *Poduridae*

1. *Xenylla maritima* TULLBERG, 1869; EU
2. *Brachystomella curvula* GISIN, 1948; EU

fam.: *Onychiuridae*

3. *Onychiurus armatus* (TULLBERG, 1869) GISIN 1952; EU

fam.: *Isotomidae*

4. *Isotomurus palustris* (MÜLLER, 1776); EU; 0.25%

fam.: *Entomobryidae*

5. *Entomobrya nigriventris* STACH, 1930; EE; 57.19%
6. *Entomobrya quinquelineata* BÖRNER, 1901; EE; 19.86%
7. *Orchesella bifasciata* NICOLET, 1841; EE; 0.63%
8. *Orchesella cincta* (LINNÉ, 1758); EE; 0.73%
9. *Seira pallipes* REUTER, 1895; EE; 16.31%
10. *Lepidocyrtus cyaneus* TULLBERG, 1871; EE; 2.82%
11. *Cyphoderus albinus* NICOLET, 1841;

fam.: *Sminthuridae*

12. *Sminthurinus bimaculatus* (AXELSON, 1902); EE; 0.42%
13. *Sminthurus maculatus* TÖMÖSVÁRY, 1883; EE; 1.79%

The dominance-ratio data behind the species names mean data without *Poduridae*, *O. armatus* and *C. albinus*. The dominancy of *E. nigriventris* (57.19%) can be seen from these values. The proportions of *E. quinquelineata* (19.86%) and *S. pallipes* (16.31%) are also high.

The presence of *Poduridae* is regular only in the case of two trap-groups, on extrem dry places with degraded vegetation. But there they have mass occurrence.

Their picking means a heavy methodical problem because of their smallness and great number of occurrence (500–1000 specimens per trap-group).

The occurrence of *O. armatus* is very occassional. Being this species euedafic, the method used is not really effective for their collection.

C. albinus lives excusively in ant nests. In this particular case it was found in the nest of *Lasius alienus* FÖRSTER.

The representatives of family *Sminthuridae* have often high occurrence by using sweep nets. From this fact we can conclude that their density is higher in the grass level, their living space is not primary the ground surface.

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INDICATION OF SPATIAL HETEROMORPHY AND COMMUNITY STRUCTURE OF *ACRIDOIDEA*-COMMUNITIES IN A SANDY GRASSLAND

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(Received: July 1, 1985)

Abstract

The spatial heteromorphy indication of *Acridoidea*-communities was studied in 1983–84 on the basis of observations of dish-trap groups placed at 12 representative points of sandy grassland mosaic-complex.

The habitat points similar in their vegetational succession stage are also qualified as being of great similarity by the grashoppers. Grashopper communities plastically react to the changes in heteromorphy. The changes in their indication patterns is brought into connection with abiotic conditions as well as with the changes in individual number.

The diversity-studies refer to the patchily changing organization and the variable patterns of structures of communities.

The obtained results were compared with those of gained from previous Barber–trap method. These showed good correlation in general, despite the relative frequency is effected by the differences between the two methods.

Key words: Acridoidea, community structure, succession, indication of heterogeneity

Introduction

The grashoppers generally form significant herbivore guilds in the grass biocenoses (see Andrzejewska and Gyllenberg, 1980 as a review). Their significance is particularly great at the dry grasses of the Southern Great Hungarian Plain (Gausz, 1971–72), this gives reason for their detailed ecological processing at these habitats.

In this respect, it is found particularly important to study the effects of the changes — e.g. successional — taking place in the characteristics of the habitat exerted on its populations and communities. To decide the question it is evidently not enough to explore the *Acridoidea* populations and communities at synphenobiological level; it is also necessary to gain knowledge on the ecological background — first of all the vegetational characteristics (cp. Capinera and Sechrist, 1982; Evans et al. 1983; Monk, 1985, etc.).

The sandy plain belonging to the Kiskunság National Park — which is presently under complex ecological exploration (Gallé et al. 1985a, 1985b) — has favourable fundamentals for studies on the above-mentioned problem.

The principle question of our present paper is the examination of the similarities and dissimilarities between plant- and *Acridoidea*-communities in the community level reaction to spatial heteromorphy („heteromorphy-indication").

This was achieved in two ways. On the one hand, studies were performed on the „fine grained" and „coarse grained" behaviour of the two community types, on the basis of the similarity of the samples originating from the various patches. On the other hand, the diversity-relations of the communities living in the various patches of the habitat as well as the dependence of the *Acridoidea* diversities on the vegetational diversity were analysed.

The relationship between diversity and spatial heterogeneity has been pointed out by MURDOCH et al. (1972). SOUTHWOOD et al. (1979) have called attention to the connection of the diversity changes in the plant- and insect-communities, in the different stages of secondary succession. The diversity of specifically grashopper-communities has been studied by PFADT (1982, 1984).

Materials and methods

1. CHARACTERIZATION OF SAMPLING AREA

The area chosen for studies is a 2.4 ha of the Bugac sandy grassland belonging to the Kiskunság National Park, not being grazed since 1976. Its surface is heteromorph, containing 2–3 m high sand-hills and wind-furrows dissecting them. Beyond the surface heteromorphy, the heterogeneity of the vegetation is also due to a secondary successional process resulted by the cessation of grazing. The plant-association reflecting the effect of grazing, the *Potentillo-Festucetum pseudovinae*, is the starting-point of a succession having two trends dependent on height of the habitat part in question. On the sand-dunes representing the higher level it turns into natural, open sandy grassland, *Festucetum vaginatae danubiale*, while into the closed, higher grassed *Molinio–Salicetum* association in the lower, more humid wind-furrows.

The initial stages of artificially induced (watering, removal of upper soil layer) successional processes were also studied at plots established for the purpose of field experiments.

2. SAMPLING METHODS

Barber–traps and dish-traps were used for the continuous studying of the insect-communities of the sample area. The results of the studies performed with Barber–traps have been reported on elsewhere (GALLÉ et al. 1985a, 1985b), in the present paper they are used for comparison.

The dish-traps were plastic vessels of 15 cm diameter and 6 cm height. These were placed in groups of five at 12 points of the sample area, lowered 2 cm deep in the soil. Ethylene-glycol was applied as killing-agent and the collections were repeated in two weeks' intervals. The traps functioned from May till October in the years 1983–84. 6971 individuals were sampled in 1983, and 2521 in 1984.

In 1983, the composition and total coverage of the vegetation, as well as the relative frequency of the various species were determined in a 2 x 2 m district in the area of the traps.

3. PROCESSING METHODS

The similarity between the various sampling points was determined by cluster analysis on the basis of the Renkonen and Czekanowski indexes. The „coarse grained" and „fine grained" behaviour, resp., are characterized by the average of the similarity indexes ($\bar{C}$) and their coefficients of variation $S_C/\bar{C}$ (GALLÉ et al. 1985b).

The Shannon function was applied for measuring diversity, and the dominance-diversity curves based on the species-individual distribution were also applied for the further characterisation of the community-structure.

In every case the correlation studies were carried out on the basis of the linear (L), logarithmic (LOG), exponential (EXP) and power index (POW) functions.

Results and discussion

1. HABITATS

Vegetation types found at the sample are shown in Table 1. Signs in the Table: The relation signs refer to the dominant plant-communities at the places with mixed stand. The fine deviations in the different patches are demonstrated by the indication of the species participating to a considerable degree in the coverage (CY: *Cynodon dactylon*; ME: *Medicago minima*; CA: *Carex liparicarpos*; EU: *Euphorbia sequieriana*; SE: *Sedum acre*; GA: *Galium verum*). The point labelled FV/PFP/<SE represents a habitat of characteristic composition, where the *Sedum acre* appears with higher individual number than the *Festuca*. The dominating species at the 1. and 2. sampling site being close to primary successional stage is the *Euphorbia sequieriana* (EU) in one case, and the *Cynodon dactylon* (CY) in the other. According to the total coverage values the joint characteristic of the listed sites (with the exception of the two MSR variants) is the relatively low surfaced coverage, ranging between 0.3–0.6.

Table 1. Vegetational data of the sampling sites

Serial Number	Community type	Coverage	Space-level Difference	Experimental effects
1.	EU	0.15	+	removal of upper soil layer in 1981
2.	CY	0.30	+ +	
4.	PFP	0.30	+ +	
3.	PFP>FV	0.30	+ + +	
12.	PFP>FV(CY)	0.50	+ +	
11.	FV>PFP	0.35	+ +	watering isolated in 1984
10.	FV>PFP(CA)	0.45	+	
9.	FV>PFP(ME)	0.65	+	
5.	FV(PFP)<SE	0.50	+ + +	
7.	FV>PFP(CY)	0.60	+ +	
6.	FV⩾PFP	0.20	+ +	
8.	FV⩾EU	0.40	+	
13.	MSR(GA)	0.95	–	
14.	MSR(CY)	0.95	–	

The number of + signs increases with the raise of the space-level.

2. HABITAT-HETEROMORPHY INDICATION

Fig. 1. shows the dendrogram of the cluster analysis between the sites carried out on the basis of the percental coverage values of the plant species. It can be seen that the similarity levels of the dendogram link the habitats having *Festucetum vaginatae* (FV) dominance into groups similar in 72–86, and 73–76%, resp. The looser linkage of the FV/PFP/ < SE type habitat is due to its characteristic vegetation.

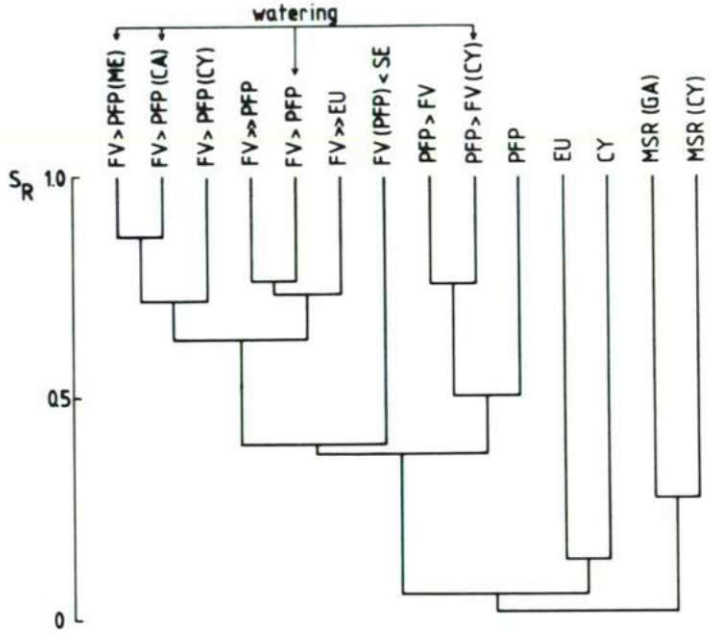

Fig. 1. Dendrogram of the vegatation according to Renkonen similarity analysis.

The segregation of the group of PFP and PFP>-like patches, and their lower (51–76%) similarity are well reflected. The characteristic vegetation of the nearby primary succession- (EU and CY) and *Molinio–Salicetum* (MSR)-type habitats is expressed in the low leveled similarity relationships (13.6 and 17.3%, resp.).

Therefore, the clusters of the dendrogram form groups according to the successional stages of the area. The majority of the sample sites of the present study represent a series of successional states being prior to the development of the sand-dunes, seminatural grassland of the *Festucetum vaginatae*, and the habitats of lower level included in the study in 1984 show patterns already segregated from the PFP- > MSR transition, which have reached a later successional stage.

The spatial heterogeneity qualification of the *Acridoidea*-communities in the above-mentioned habitat-combination was also studied by cluster analysis, both in 1983 and 1984 (Figs. 2 and 3). Distribution similar to that gained for the plants was

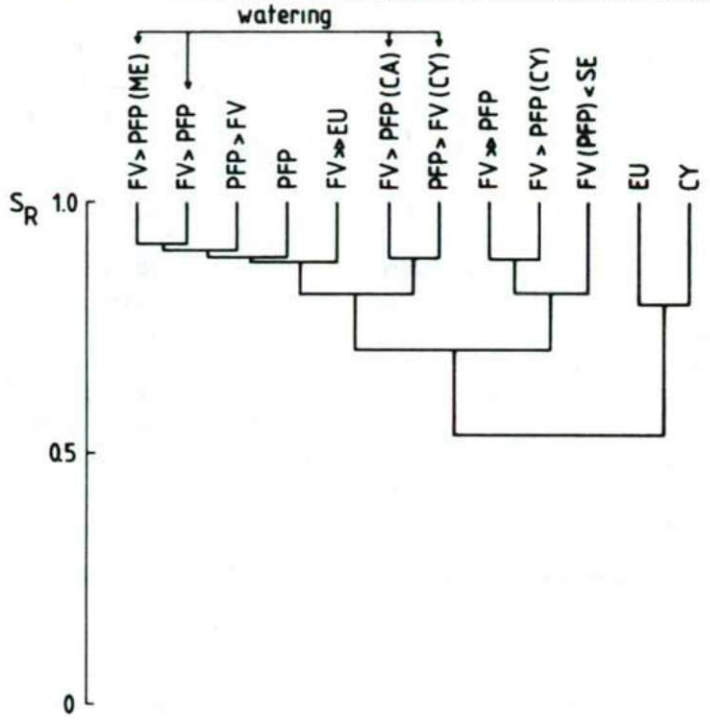

Fig. 2. Dendrogram of *Acridoidea*-communities according to Renkonen similarity analysis in 1983.

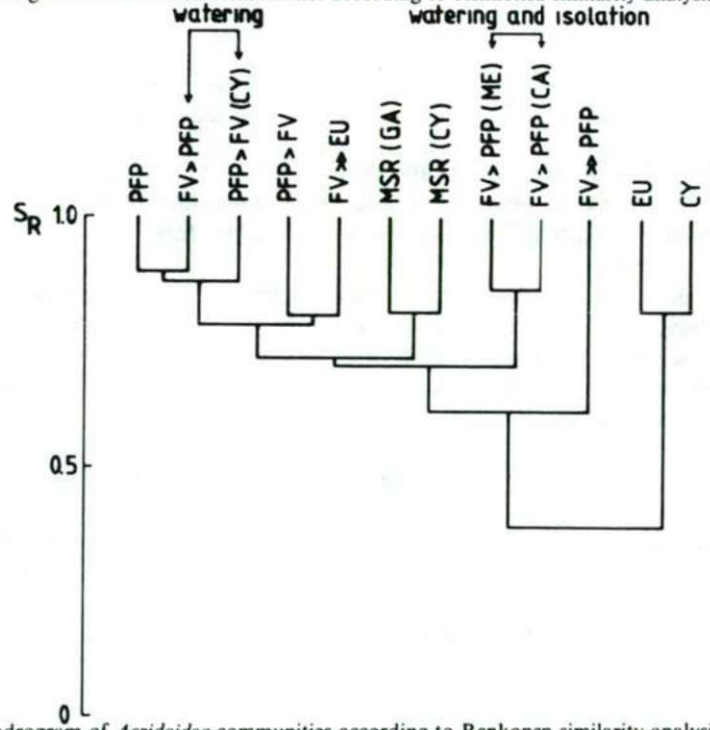

Fig. 3. Dendrogram of *Acridoidea*-communities according to Renkonen similarity analysis in 1984.

only partially observable between the habitats on the basis of grashoppers. Even the grashoppers make distinction at places where there are greater differences in vegetation or height — e.g. segregation of MSR and primary succession-close (EU and CY) habitats — but contrary to the plants, the similarity relations are of higher level here, too.

Accordingly, the similarity analyses refer to the fact that the grashoppers regard the habitat more homogeneous than the vegetation. This is well reflected by the elemental means of the similarity matrices ($\bar{C}$) as well as the variational coefficient values $S_C/\bar{C}$. Namely, it is evident that the finer indicational sensitivity, the realization of the „coarse grained response" is indicated by the lower similarity average and higher variational coefficient.

During the course of the similar evaluation pertaining to the Barber–trap recordings (GALLÉ et al. 1985b) it was manifested that the vegetation has better indicational ability compared to the animal communities, since the highest variational coefficient value was obtained for the vegetation($S_C/\bar{C} = 1$). This is confirmed by the present analysis (Table 2).

Table 2. Similarity averages and variational coefficients calculated from the Renkonen similarity matrix of the vegetation

		$\bar{C}$	$S_C/\bar{C}$
Dish–trap :	1983	35.77	0.74
	1984	24.31	1.15
Barber–trap :	1981	26.00	1.00

The deviation between the years 1983 and 1984 is caused by the fact that in 1984 two *Molinio–Salicetum*-covered patches were included in our studies, being of extreme character compared to the previous ones, and this is evidently apparent in the similarity means.

The grashopper communities and their seasonal changes were also studied by similar technique. Besides the data of the Renkonen similarity matrices, the $\bar{C}$ and $S_C/\bar{C}$ values were analysed according to the Czekanowski method as well. Since there is only slight deviation between the values obtained by the two methods, only the result of the Renkonen analysis is demonstrated (Fig. 4).

The deviations for 1983 and 1984 in the heteromorphic indication are similar to those of the vegetation here, too, and can with all probability be traced back to the previously mentioned causes.

According to Fig. 4. differences are demonstrable in the $\bar{C}$ and $S_C/\bar{C}$ values. As there are also differences in the individual numbers collected throughout the two years, this raises the possibility of the density-dependence of the heteromorphic indication. The data of the Barber–trap recordings are suitable for studying this

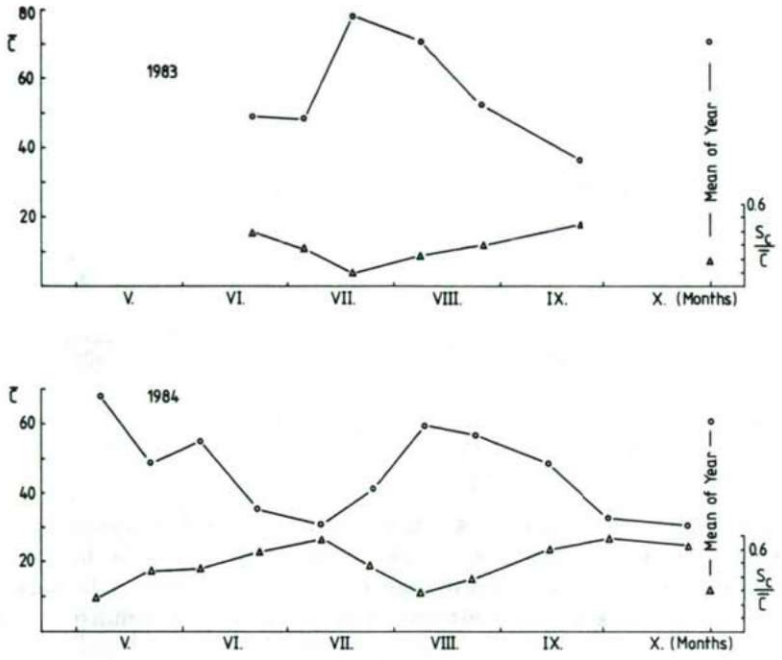

Fig. 4. Averages and variational coefficients of the Renkonen similarity indexes of *Acridoidea*-communities in the time-periods of the dish–trap samplings.

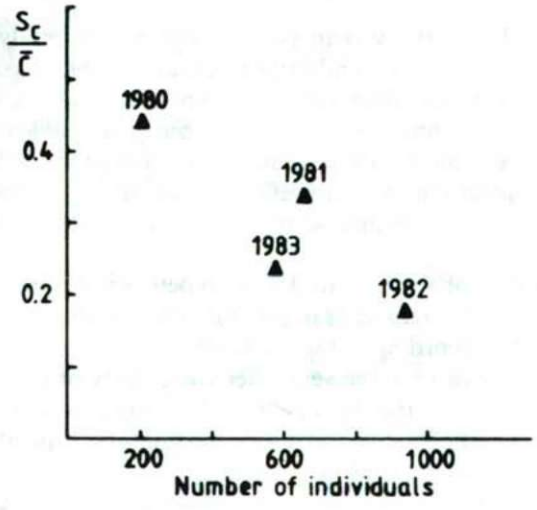

Fig. 5. Changes of the variational coefficient values in the function of the total individual numbers of the dominant species (*Euchorthippus* and *Calliptamus*) in the years 1980–83, on the basis of Barber–trap recordings.

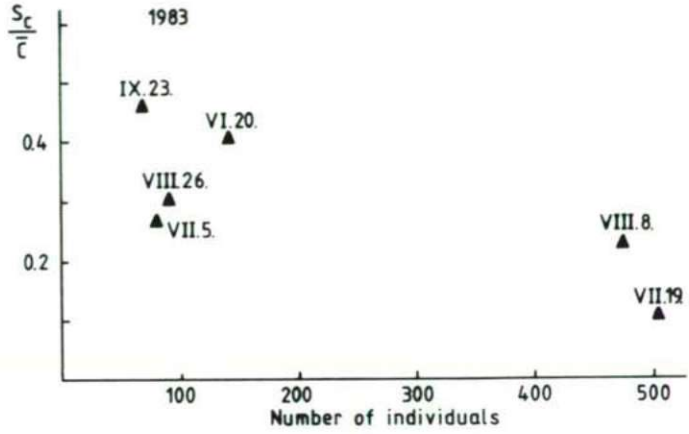

Fig. 6. Changes of the variational coefficient values in the function of the total individual numbers of the dominant species (*Euchorthippus* and *Calliptamus*) in the sampling time-points of the 1983 dish–trap collecting.

question, because the results of 4 years are at disposal for comparison. The relationship between density and heteromorphic indication is unambiguously negative here (Fig. 5). The changes in seasonal density, which may be estimated on the basis of the dish-traps, too, exert similar effect on the heteromorphic indication (Fig. 6).

3. Correlation of similarity values

A further possibility of study is to perform correlation analysis between the data-pairs corresponding to the similarity matrices of the vegetation and the insect-community. In such case data can be obtained in respect to the similarities and deviations, resp., regarding the spatial heteromorphy indication of the two communities in the qualification of the similarity to each other of the various sites (Table 3 and 4). The linear correlation coefficient (L) values are indicated in every case, other correlational data are only shown in case they surpass the value gained for L.

According to the data of Table 3. the deviation between the linear and non-linear correlation coefficients is not significant in general. The correlation values are higher for 1983 than for 1984. Accordingly, the correlation between the behaviour of the two community types is greater in the year when the density of the grashoppers and the homomorphic degree of the habitat is also higher. From the coefficients calculated on the basis of the Barber–traps, the outstanding value obtained for 1982 can be back to similar reasons (Table 4).

Furthermore, it was also studied what correlational connections could be demonstrated between the grashopper communities at the dish-trap habitats between 1983–84 and their close seasonal time-points (Table 5), as well as between 1980–83 at the Barber–trap habitats (Table 6).

Table 3. Correlation between the vegetation and the Renkonen similarity values of the *Acridoidea*-communities, on the basis of dish–trap collecting (correlation calculated on the basis of L: linear-, LOG: logarithmic-, EXP: exponential-, POW: power index functions)

1983			1984		
VI.20.	0.44 L	$p<0.001$	V.7.	0.36 L	$p<0.01$
	0.50 LOG			0.38 LOG	
VII.5.	0.48 L	$p<0.001$	V.22.	0.48 L	$p<0.001$
VII.19.	0.56 L	$p<0.001$	VI.5.	0.48 L	$p<0.001$
	0.62 LOG				
	0.63 POW		VI.22.	0.18 L	$p>0.1$
VIII.8.	0.66 L	$p<0.001$	VII.10.	0.41 L	$p<0.001$
	0.70 LOG				
	0.70 POW		VII.25.	0.21 L	$p>0.1$
VIII.26.	0.47 L	$p<0.001$	VIII.9.	0.46 L	$p<0.001$
	0.48 EXP				
			VIII.24.	0.20 L	$p>0.1$
IX.23	0.17 L	$p>0.1$		0.24 EXP	$p<0.1$
	0.18 EXP				
	0.20 LOG		IX.14.	0.15 L	$p>0.1$
	0.23 POW	$p\sim0.1$			
			X.2.	0.13 L	$p>0.1$
All year:	0.60 L	$p<0.001$		0.23 LOG	$p\sim0.1$
	0.61 EXP				
	0.64 LOG		X.25.	0.27 L	$p\sim0.05$
	0.65 POW		All year:	0.42 L	$p\sim0.001$

Table 4. Correlation between the vegetation and the Renkonen similarity values of the *Acridoidea*-communities, on the basis of Barber–trap recordings

1980	0.33 L	$p<0.01$
1981	0.30 L	$p<0.02$
	0.32 POW	$p\sim0.01$
1982	0.53 L	$p<0.001$
1983	0.18 L	$p>0.1$
	0.21 POW	$p<0.1$

Table 5. Correlation of the Renkonen similarity values of *Acridoidea*-communities in 1983-84 at the dish-trap collecting sites

1983.VI.20. x 1984.VI.22.	0.50 L	$p<0.001$
1983.VII.10. x 1984.VII.25.	0.51 L 0.53 LOG	$p<0.001$
1983.VIII.8. x 1984.VIII.9.	0.721 L 0.722 LOG 0.728 POW 0.729 EXP	$p<0.001$
1983 x 1984	0.81 L 0.82 LOG 0.82 POW	$p<0.001$

Table 6. Correlation matrix of the Renkonen similarity values of *Acridoidea*-communities on the basis of Barber-trap recordings

	1980	1981	1982	1983
1980		0.38 L $p\sim0.001$	0.28 L $p\sim0.02$	0.069 L $p<0.1$
1981			0.43 L $p<0.001$	0.26 L $p<0.05$
1982				0.33 L $p<0.01$
1983	0.074 LOG $p>0.1$	0.29 LOG $p<0.02$	0.34 LOG $p<0.01$	

On the basis of the results, much higher correlational coefficients could be found for the sites trapped by dish-traps than at the patches where Barber-traps were used. Evidently, definite standpoint concerning the evaluation of the correlational relations would not be suitable here, either, nevertheless, we can conclude that there must be considerable differences in community-structure in the two habitat- combinations, or the underpresentation of the grashopper populations in the Barber-traps causes stronger stochasticity in the composition of the collected material.

4. DIVERSITY RELATIONS

There are significant deviations between the diversity-changes of the plant- and grashopper-communities living at the various sites (Fig. 7). Since the insect community in question is herbivore, it may be striking that the *Acridoidea*-communities have greater diversity at patches with small plant-diversity. However, the analysis of these patch-types points to the fact that these possess the physical conditions (small surface coverage, higher relief, xerothermic relations) favourable for the xero- and geophyl species. At the same time these habitats differ from each other in respect to their successional condition. The EU, CY and PFP are habitats of initial- and early-successional stage, while the FV ≫ types are the representatives of natural grasses of late-successional stage. The degree to which the successional stage of a habitat may be determinant on the species composition of the insect community living at it — in our case the grasshopper community — is shown by the following example. In both years of the dish-trap studies the geophyl species (*Oedipoda coerulescens* L. 1758, *Oedaleus decorus* GER. 1826, *Celes variabilis* PALL. 1771) and the *Dociostaurus brevicollis* EVER. 1848 of Southern distribution occurred with greatest individual number in the habitats of initial succession, having small coverage (EU and CY). On the contrary, at the natural grasses (FV ≫ PFP and FV ≫ EU) the listed geophyll species did not occur at all, or only 1–1 individual, and the *D. brevicollis* was only represented in 20–50% of the former value.

It is also a characteristic feature that in 1984, apart from the drastic decrease in the total individual number of the *Acridoidea* there was an increase in the diversity of the grasshoppers at every sapmled site. The presumable explanation to this is the change in the population-ratios accompanying the decrease in the individual number,

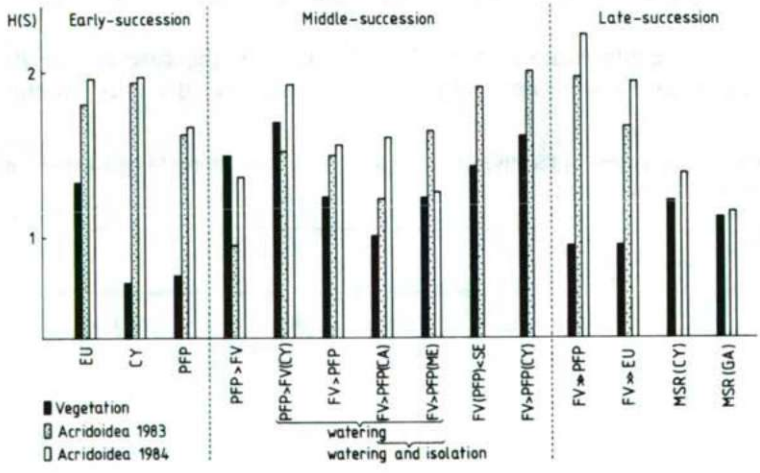

Fig. 7. Diversity values of the vegetation and the *Acridoidea* communities at the various succession staged habitats, on the basis of dish-trap collecting.

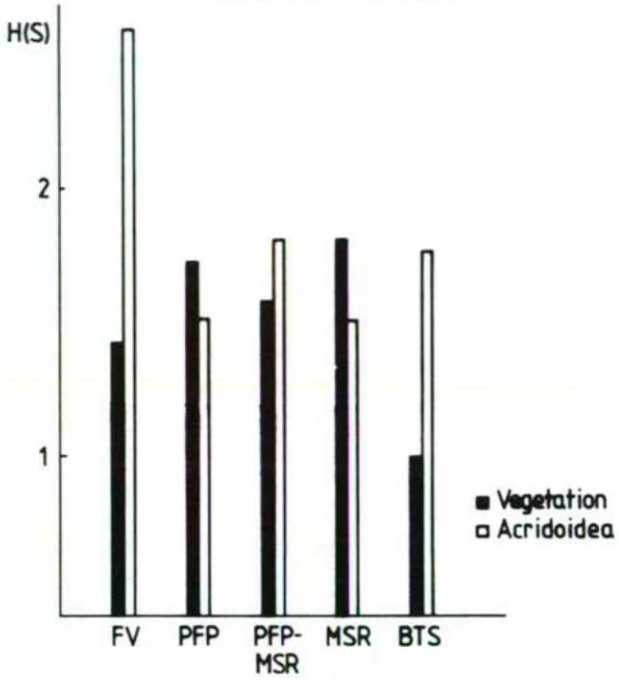

Fig. 8. Diversity values of the vegetation and the *Acridoidea* communities at the Barber-trap patch-types in 1981.

first of all the decreased ratio of two dominant species (*Calliptamus italicus* L. 1758 and *Euchorthippus declivus* BRIS. 1848), and thus the increase in the evenness component of diversity.

Similar diversity-relations were found earlier in the case of the Barber–trap studies, too (Fig. 8), since here, also a high grasshopper-diversity accompanied the

Table 7. Correlation matrix of the diversity of vegetation and grasshopper-communities on the basis of the dish–trap collecting

	1	2	3
1(Vegetation)	–	–0.15 L –0.20 POW	–0.21 L –0.26 LOG
2(Acrid.1983)		–	0.83 L 0.85 EXP $p < 0.001$
3(Acrid.1984)			–

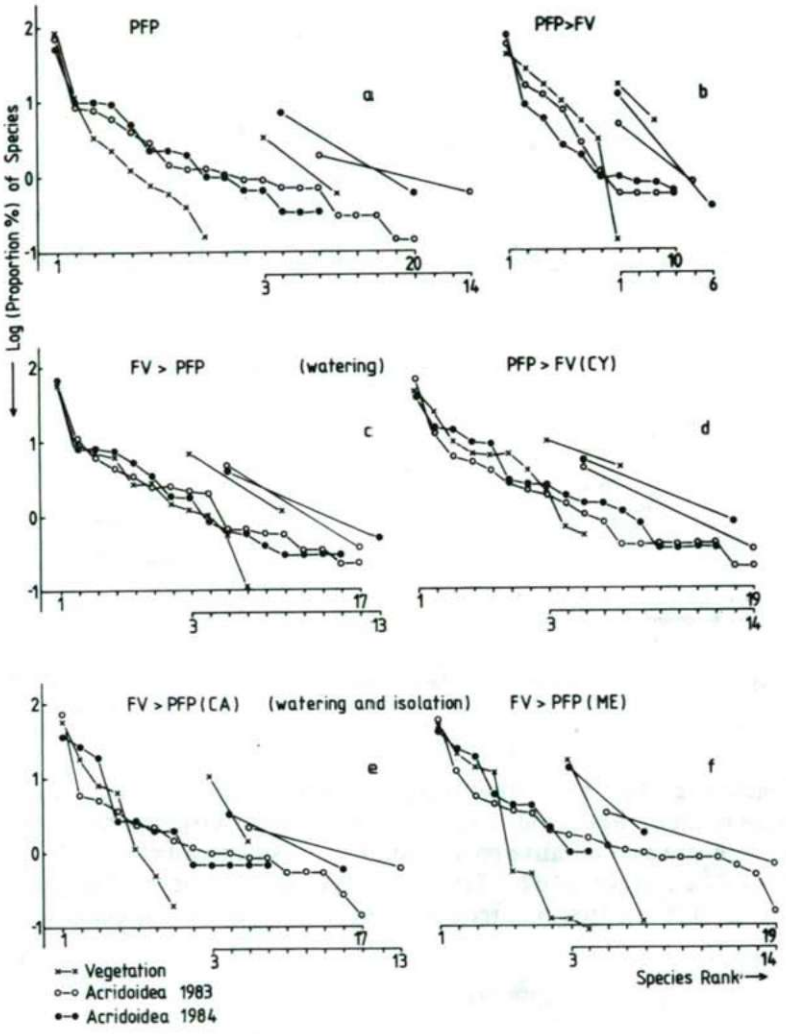

Fig. 9.a–f. Dominance-diversity curves at the succesional habitats of the dish-trap collecting.

lower plant-diversity of the *Festucetum vaginatae* (FV). An unexpected high grasshopper-diversity was manifested in the *Brometum tectoris Secale facies* (BTS) degraded association as well. This was striking because other insect communities (*Cicadinea*, *Heteroptera*, *Formicoidea*) showed the lowest diversity here (see GALLÉ et al. 1985b). The divergent behaviour of the grasshoppers can probably be explained by the fact that the xerothermic conditions caused by degradation are favourable for this insect-group of high heat demand.

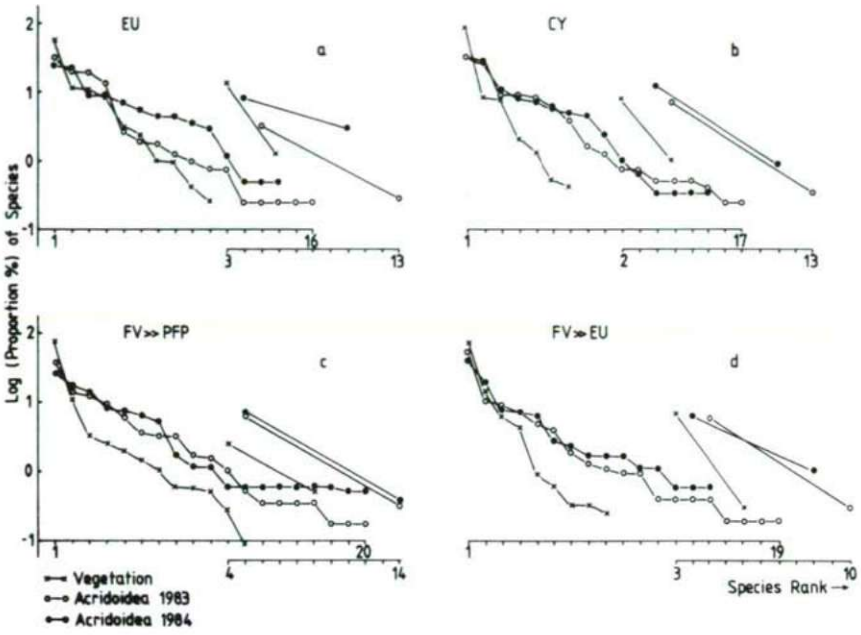

Fig. 10.a–d. Dominance-diversity curves at the primary- (a,b) and late-successional (c,d) habitats of the dish–trap collecting.

Concluding from the contradictory tendencies found in the above diversity-relations the result of the correlation study between the diversities is not striking (Table 7), since in every case negative connection was experienced between the vegetation- and *Acridoidea*-diversities. This fits well to the Barber–trap studies, where 'r' was found to be -0.388 in 1981. On the contrary, there is a tight correlation between the

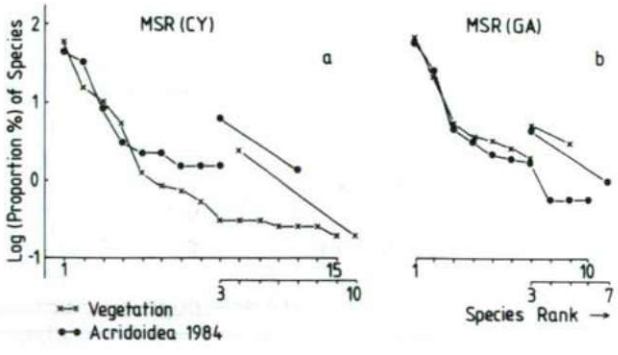

Fig. 11.a–b. Dominance-diversity curves in the associations of lower space level.

diversity values of the grasshopper communities, referring to the fact that the vegetational background of our trap study can be evaluated as the habitat of grasshopper-groups of stable community structure.

5. DOMINANCE-DIVERSITY

Beyond the diversity-relationships, the dominance-diversity curves as well as the slopes of their median section may provide help for the further characterisation of the community tructure (Figs. 9–11). The curves give good illustration of the community structure deviations at the 12 trap sites. The Figures also show the straight lines drawn with the slopes obtained pertaining to the median section of the dominance-diversity curves. Their unchanged nature between the years can be applied for the indication of the structural stability.

At the medial-successional *Potentillo-Festucetum pseudovinae* community habitats (Figs. 9.a–f.) the species-richness of the vegetation is balanced, the number of species ranges from 7 to 11. The number of species of the grasshoppers is high (17–20) and at the undisturbed (non-treated) places they show rather similar community structure in both years. At two sampling sites, however, the unfavourable effect of isolation on the arrangement of the grasshopper-communities is rather striking, since following this perturbation the number of species of the grasshoppers decreased from 17 to 12, and from 19 t0 9, resp., in 1984 (Figs. 9.e–f.). At the PFP > FV labelled sample site the modification of the dominance-diversity curves for the grasshoppers and the low species number are striking, as due to the great similarity of the vegetation the organization of grasshopper-groups having structure similar to the other places transitory in succession would be expected (Fig. 9b).

At the primary- (EU and CY) and late-successional staged habitats having *Festucetum vaginatae* (FV $\gg$) dominance (Figs. 10.a–d.) the number of plant species is 7-10 and 9-12, resp. The number of species of the grasshopper communities is high here, too, (14–20) however, the individual distribution shows less evenness than at the median-successional patches. The straight lines indicating stability show varying picture.

According to expectations, the number of species of the grasshopper communities is the lowest (9–10) in the *Molinio-Salicetum* association (MSR). It is interesting that at the two collecting sites of MSR the structure of the grasshopper-groups are rather similar although the composition of vegetation is different.

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THE *CICADINEA* FAUNA OF SODIC ZONATIONS AT THE SOUTHERN LOWLANDS

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Abstract

10 out of 51 *Cicadinea* species formed 90% of the occurring individuals demonstrated at three sodic zonations differing from each other in 10–15 cm ground level heights. Half of the larvae develops at the lowest level, the imagos, however, prefer dwelling in the middle zone. The fauna of the driest area is the best segregated, while for the vegetation this is observable at the periodically inundated third level. The distribution of the *Cicadinea* is determined by the dominance as well as the chemical state of the host-plants influenced by the underground water. The leafhopper fauna is segregated according to the aspects of spring, beginning of summer and late summer — autumn. The seasonal segregation between the species is much more expressed than that of according to zonations, which may change seasonally. The water perturbation affecting the 3. level exerts influence on the individual density, spatial differentiation of the *Cicadinea* fauna at all three zonations, as well as on the further aspects through the early spring aspect.

Key words: Leafhopper, zonation, seasonality, diversity, bionomic data.

Introduction

From faunistic point of view, only rather few studies have been performed at the Southern lowlands in many respects — thus in that of the *Hemiptera*.Data relative to this can be found in the manuscript of a lecture by G. HORVÁTH (1906) (mentioned of 56 *Cicadinea* species from Bácska) and a few concrete data can be found in the 3. volume of the Fauna Regni Hungariae, resp. (HORVÁTH, 1918). The more recent scanty literature is firstly pertaining to other areas of the Lowlands (KOPPÁNYI and WOLCSÁNSZKY, 1955; KOPPÁNYI, 1960; OROSZ, 1981; GYÖRFFY, 1982).

Preliminary surveys at the studied area have been carried out with Malaise trap, the results of which have partially been published (MÓCZÁR and GYÖRFFY, 1981). The present paper is a part of a large-scale undertaking, within the frame of which the *Arthropoda* fauna of the characteristic habitat-types at the Southern lowlands will be explored. The studied areas are firstly grass-types. Within this the sandy grasslands are dominating, and the grasses found at the sodic areas, being the subject of the present study, are also important. The significance of the leafhopper fauna is verified by the fact that it is the dominant insect-group both at the chalky and

Table 1. Percentage distribution of the material collected at the studied areas (without *Acari* and *Collembola*)

Groups	1982			1983		
	Areas					
	1(%)	2(%)	3(%)	1(%)	2(%)	3(%)
Aranei	6.94	5.11	8.24	8.27	7.56	8.28
Auchenorrhyncha	27.43	20.39	22.32	37.35	39.99	43.81
Coleoptera	2.71	3.67	2.89	2.44	3.39	2.86
Diptera	26.99	24.85	21.34	6.17	7.4	7.16
Heteroptera	5.62	S4.06	14.03	9.98	15.05	7.93
Hymenoptera	10.42	19.85	15.53	19.01	18.39	15.71
Physopoda	1.24	0.5	2.97	4.98	0.73	4.25
Sternorrhyncha	18.3	29.48	13.06	5.62	5.73	7.78
Others*	0.35	2.09	0.61	6.16	1.75	2.22

* *Lepidoptera, Orthoptera, Psocoptera, Neuroptera, Diplopoda, Gastropoda*

acidic ground grasses (MORRIS, 1971; WALOFF and SOLOMON, 1973; WALOFF, 1980; DENNO, 1980; and others). The *Auchenorrhyncha* constituted the major part of our collected material, too (Table 1).

Studied area and methods

The studies were performed in the years 1982–1983 at Kiskundorozsma located 7 km from Szeged, at the nature conservancy area named „Dorozsmai Nagyszék". The area has characteristically solonchak sodic soil where the height difference of 10–15 cm has developed a well recognazible level of three zonations. This is mainly caused by the ground level difference, influencing salt-accumulation and the more soluble or concentrated occurrence of salts, resp. (BODROGKÖZY, 1965, 1980). The area has hard ground, thus even less plant species find their essential conditions here than at similar sodic soil with looser structure.

During the course of our studies two dry and one watery sodic phytocenoses were segregated.

1. The highest located level, thus being the driest, with soil easily drying out even in summer. Its width is about 50 meters. Phytocenosis: *Festucetum pseudovinae* (MAGYAR 28) Soó 33. Besides the grass-forming short grassed *Festuca pseudovina* the dominating species at the area was the *Cynodon dactylon*. The average height of the grass is 10 cm. The total covering value was 110% owing to the relatively high quantity of the dicotyledons.

2. Level of good water-supply, drying out less easily and not inundated yet. Its width varies, generally being 10–15 meters. Phytocenosis: *Festucetum pseudovinae* (MAGYAR 28) Soó 33. The association has a coverage of 95–100%. The dominant grass is the *Festuca pseudovina*, which strongly raised the mean height of the grass level. Its species composition is rather close to that of the previous level, only the dominance-relations are changed by the more favourable water-supply. This cenosis was the freshest among the three.

3. Deepest level, being moister in spring (e.g. in 1982, too), and inundated till the beginning of summer. Even the summer rainwater may remain at this level long-lastingly, therefore it belongs to the category of the watery sodic soils. This is the widest zonation, being over 100 meters wide. Phytocenosis: *Puccinellietum limosae* (RAPAICS 27) SOÓ 30. The transition of the two and three associations into each other is manifested in certain cases. This is possible if the sodic-grade is relatively dry and the spring shallow inundation ceases or only lasts for a short period. At comparatively moister areas the *Puccinellia* may penetrate into the gaps of the *Festucetum* grass (VARGA, 1983). This could be found in the second cenosis where, though in blades, the *Puccinellia* was present.

The collections were performed from March–April till the middle of October. 5–5 quadrate-samples of 1/4 m^2 area were taken at every zonation level with the help of „Suction-trap" (GYÖRFFY, 1980). The *Arthropoda* samples were obtained from the debris with the method of MARSTON–HENNESSEY (1978), then stored in 70% alcohol following selection under microscope. RENKONEN's similarity index, CZEKANOWSKI's similarity index, and SHANNON's diversity value were applied for evaluations further to those of the faunistic data, and in cases dendrograms were prepared from the similarity matrix with the help of Cluster analysis.

Results

I. Faunistic characterisation

HORVÁTH (1918) mentions altogether 6 species from the Dorozsma site, from which only two could be found in the material collected by us (*Delphax minuscula* HORV., *Eurysa clypeata* HORV.). Unfortunately their closer site cannot be identified.

The representatives of 37 identified species were collected during the course of the two years (Table 2). Four of these were only found in larval form (*Chanithus pannonicus* GERM., *Eupelix cuspidata* F., *Ommatidiotus dissimilis* FALL., *Trypetimorpha fenestrata* COSTA). Besides these, the following species were collected during the course of the Malaise-trap studies on the flying insect fauna (MÓCZÁR and GYÖRFFY, 1981), — not reported on as yet: *Allygus atomarius* FABR., *Cicadella viridis* L., *Cicadula placida* HORV., *Delphacodes audrasi* RIB., *Dictyophara europaea* L., *Empoasca affinis* NAST., *Lepyronia coleoptrata* L., *Macropsis marginata* H.S., *Oliarus quinquecostatus* DUF., *Opsius stactogalus* FIEB., *Paramesus obtusifrons* STAL., *Philaenus spumarius* L., *Reptalus panzeri* LÖW., *Streptanus aemulans* KBM. So far a total of 51 *Cicadinea* species have been demonstrated at the area. Compared with the species number found at other grasses (PRESTIDGE, 1982; MORRIS and PLANT, 1983; ANDRZEJEWSKA, 1965; etc.), and in the knowledge of the extreme relations of the collecting site as well as the species number- and architectural flatness of the vegetation, this number seems to be rather high. If, however, it is taken into consideration that the majority of the occurring animals were probably only temporarily staying at the area, flying over it, i.e. they presumably originated from the neighbouring places — this being manifested by the very low dominance-percentages as well as by the lack of host-plants — the number of species which can be rendered probably characteristic to the area forthwith decreases. More than 90% of the occurring individuals belonged to about only 10 species.

Table 2. Dominance-relations of the *Cicadinea* populations in the 3 zonations

	1982			1983		
	1(Dp.c.)	2	3	1	2	3
Agallia laevis RIB.	0.57	0.43	–	–	0.49	0.26
Anaceratagallia ribauti OSS.	1.72	0.43	–	–	0.98	0.80
Aphrodes albiger GERM.	–	–	–	1.61	0.24	0.26
Aphrodes serratulae F.	–	–	–	–	0.24	–
Arocephalus languidus FLOR.	–	–	0.74	2.41	–	–
Artianus interstitialis GERM.	–	–	0.59	–	0.49	0.26
Balclutha punctata FABR.	–	–	–	–	–	0.26
• *Chanithus pannonicus* GERM.	–	–	–	–	–	–
Deltocephalus pulicaris FALL.	6.03	1.13	0.59	2.41	0.73	0.53
Doratura heterophylla HORV.	0.86	–	–	7.25	0.24	–
Doratura homophyla FLOR.	1.72	0.92	0.59	4.93	0.24	1.07
Doratura stylata BOTH.	–	–	–	1.61	0.98	0.26
Dryodurgades dlabolai WAGN.	0.28	–	–	–	–	–
• *Eupelix cuspidata* F.	–	–	–	–	–	–
Eurysa clypeata HORV.	6.99	5.09	11.80	–	22.54	21.50
Kelisia guttula GERM.	–	–	–	0.80	–	–
Kybos hungarica RIB.	0.28	0.81	–	–	–	–
Kybos sp.	0.57	–	–	–	–	–
Laodelphax striatellus FALL.	0.86	0.27	1.79	–	–	–
Limotettix striola FALL.	0.57	0.21	1.34	–	–	–
Macrosteles laevis RIB.	0.86	1.19	1.79	–	–	–
Macrosteles sordidipennis STAL.	–	0.21	–	–	–	–
Mendrausus pauxillus FIEB.	0.86	–	–	22.58	0.49	0.26
Metadelphax propinqua FIEB.	9.76	2.16	–	–	–	–
Neophilaenus campestris THUNB.	0.28	0.21	1.19	–	0.24	–
Neophilaenus minor KBM.	–	0.54	–	–	0.24	–
• *Ommatidiotus dissimilis* FALL.	–	–	–	–	–	–
Paluda vitripennis FLOR.	3.44	0.54	–	16.12	0.24	0.26
Psammotettix confinis DHLB.	6.60	27.11	2.39	–	–	–
Psammotettix provincialis RIB.	–	-	–	–	–	0.53
Psammotettix hungaricus OROSZ	20.67	59.16	70.40	16.93	70.83	72.57
Recilia schmidtgeni WAGN.	18.95	4.01	0.74	7.25	0.24	–
Struebingianella palliceps HORV.	–	–	1.19	–	–	0.53
Toya minuscula WAGN.	16.15	18.70	–	15.32	0.24	–
• *Trypetimorpha fenestrata* COSTA.	–	–	–	–	–	–
Ulopa lugens GERM.	–	–	–	–	0.24	–
Weidnerianella pellucida FABR.	–	0.21	–	–	–	–
Zyginidia pullula BOH.	0.86	0.75	4.78	–	–	–
Others	0.57	–	–	–	–	–
ΣN^{-m^2}	278.6	368.8	133.8	396.8	1305.6	1190.4

• : found only in larval stage

II. Segregation of the Cicadinea fauna according to zonations

Even from the data of Table 2. it is evident that the various species do not occur with the same dominance at all three levels. The three areas were compared on this basis with the help of the RENKONEN and CZEKANOWSKI indexes (Table 3), according to which the most segregated fauna is that of the 1. level. This segregation is to a smaller extent in 1982 owing to the spring water-perturbation. The faunas at the 2. and 3. levels are rather similar in the undisturbed year of 1983, not only in respect to species-dominances, but also that of the absolute individual numbers.

Table 3. Similarity values between the *Cicadinea* faunas of the zonation levels (R: Renkonen; Cz: Czekanowski).

1982

		2	3
1	R	56.84	35.30
	Cz	54.87	43.06
2	R		71.41
	Cz		49.50

1983

		2	3
1	R	20.57	20.10
	Cz	12.78	12.90
2	R		95.42
	Cz		92.82

The area most used for larva development and the position of imagos can be concluded from the tendency per level of the annual average individual numbers (Table 4). It can be seen from the data of the year 1983 which can be regarded as undisturbed, that about 50% of the larvae develops at the 3. zonation level. In 1982 this was only 7%. The differences in the imago:larva ratios refer to the fact (in 1983) that the imagos developing at the two extreme areas stay for longer periods

Table 4. Cicadinea annual mean individual-number ($\bar{N}m^{-2}$) at the three zonation levels

		1.	2.	3.
1982	imago	19.9o	26.34	9.55
	larva	49.71	83.77	17.44
1983	imago	30.52	100.43	91.56
	larva	88.61	188.30	260.67

at the middle zone, than at the place of their development (if considering the larva-mortality as identical). Due to the obvious great larva-mortality in 1982, the 3. level must have become repopulated again almost completely from the first two.

Since from the viewpoint of larva-development the 3. area is rather important in the case of both the *Delphacidae* and *Cicadellidae* families (Figs. 1–2.), the effect of the 1982 spring inundation could be felt throughout the whole year. According to the figures, it was the first developing larva generation that became the victim of this, therefore the second larva-maximum could not be developed in 1983.

A more precise figure could be gained than the annual average similarity if studying the similarity values calculated for the collection time-points in the course of the season (Table 5). The relative segregation of the 1. area is observable throughout the season, its similarity shows changes identical with both the 2. and 3. areas. Several maximums can be found in this respect, although these, too, hardly reach the value of 50%. The maximums follow each other cc. every two months. The fauna at the 1. level shows the highest level of evenness in the early spring,

Table 5. Similarity according to collection time-points of the leafhopper communities at the zonation levels (R: Renkonen; Cz: Czekanowski)

1982		05.20.	06.07.	06.25.	07.06	07.20.	08.03.	08.17.	09.01.	09.16.	09.30.	10.14.
1–2	R	0.00	13.32	3.44	41.57	14.71	49.10	5.00	9.25	46.66	58.96	30.35
	Cz	0.00	10.00	0.76	11.32	7.20	28.81	2.43	5.39	13.02	22.88	13.88
2–3	R	–	–	7.69	20.52	87.09	86.66	85.38	73.59	90.32	80.00	39.93
	Cz	–	–	1.05	6.38	35.52	28.12	39.39	30.41	40.44	13.48	12.82
1–3	R	–	–	80.35	15.38	12.96	38.34	0.00	18.50	46.66	47.72	25.00
	Cz	–	–	29.83	10.00	8.23	19.56	0.00	12.34	16.27	22.03	10.52
1983		04.22.	05.06.	05.26	06.09.	06.22	07.07.	07.22.	08.12.	08.30.	09.29.	10.14.
1–2	R	3.57	0.00	38.46	3.47	0.00	10.00	0.00	61.89	33.33	11.96	50.00
	Cz	2.63	0.00	7.46	1.35	0.00	6.66	0.00	27.27	5.88	3.27	2.32
2–3	R	92.85	71.42	96.29	48.68	63.41	20.00	87.50	75.75	99.99	90.19	96.15
	Cz	27.50	35.71	57.14	20.37	28.76	6.25	41.17	37.93	50.00	35.93	43.01
1–3	R	0.00	0.00	38.46	7.68	0.00	0.00	11.11	63.95	33.33	13.88	50.00
	Cz	0.00	0.00	10.00	3.26	0.00	0.00	10.00	25.00	5.88	2.29	1.85

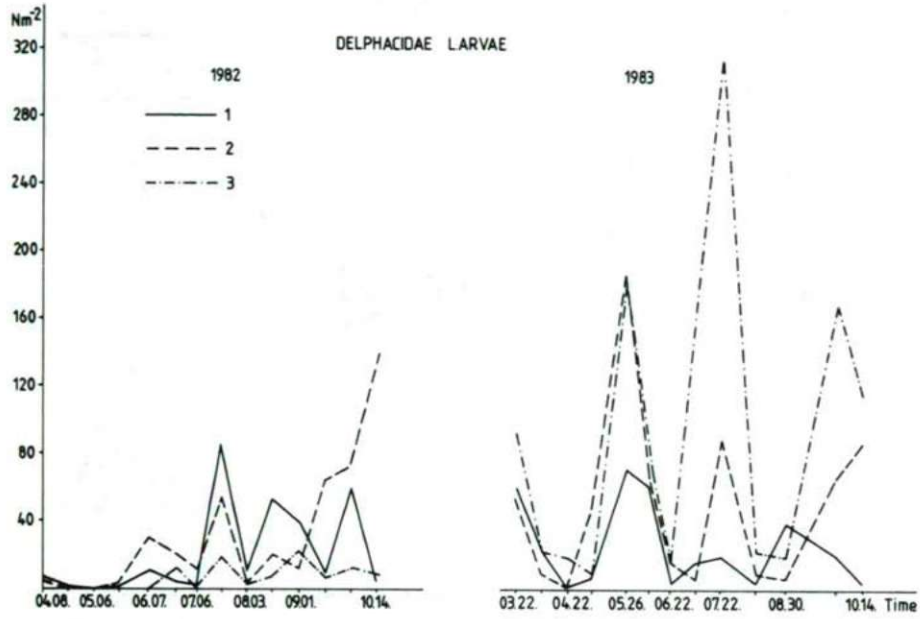

Fig. 1. Changes in individual-density of *Delphacidae* larvae in 1982–1983.

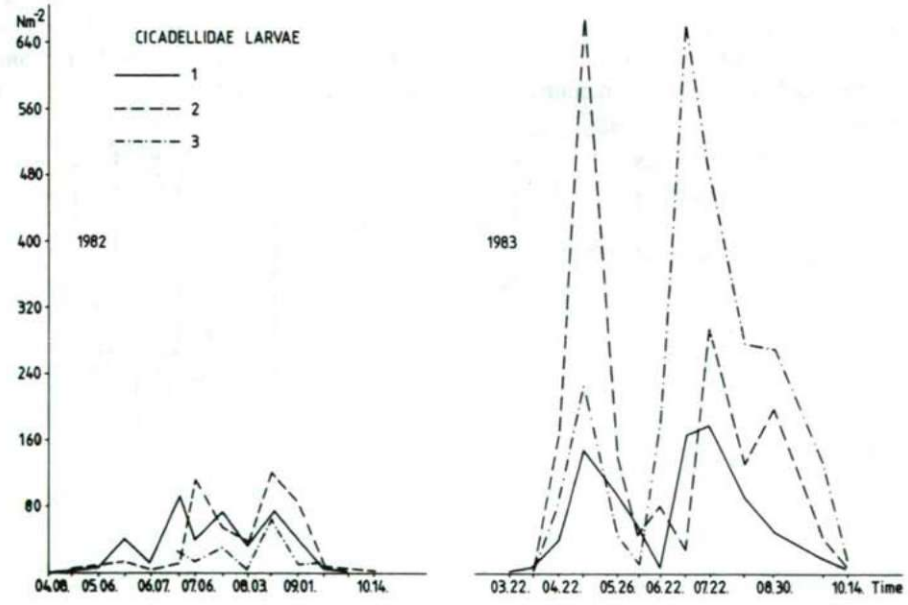

Fig. 2. Changes in individual-density of *Cicadellidae* larvae in 1982–1983.

Table 6. Percentage distribution of the 8 dominant leafhopper species per level

	Species	1982			1983		
		1	2	3	1	2	3
1	*Deltocephalus pulicaris*	77.06	19.26	3.66	37.50	37.50	25.00
2	*Doratura homophyla*	53.33	37.77	11.25	54.54	9.09	36.36
3	*Eurysa clypeata*	35.68	34.94	29.36	0.00	53.48	46.51
4	*Mendrausus pauxillus*	100.00	0.00	0.00	90.32	6.45	3.22
5	*Paluda vitripennis*	82.75	17.24	0.00	90.90	4.54	4.54
6	*Psammotettix hungaricus*	15.46	58.97	25.45	3.62	49.82	46.55
7	*Recilia schmidtgeni*	76.96	21.57	1.45	90.00	10.00	0.00
8	*Toya minuscula*	39.47	60.52	0.00	95.00	5.00	0.00

beginning of summer and autumn aspects. The faunas at the 2. and 3. levels are rather similar in both years, the RENKONEN indexes near the value of 100% on many occassions. The one single minimum value is at the beginning of July.

Among the occurring species, the abundance of 8 is great enough to study their distribution per level separately. Considering the total individual number as 100%, the percental distribution at the various areas is comprised in Table 6. Forming similarity matrix from this, and subjecting it to cluster analysis, the obtained dendograms can be seen in Fig. 3. According to this the *Mendrausus pauxillus*, *Paluda vitripennis*, *Recilia schmidtgeni*, furthermore the *Doratura homophyla*, *Eurysa clypeata* and *Psammotettix hungaricus* form two separate groups, which are only combined at low level. The former are the characteristic species of the 1. area, while

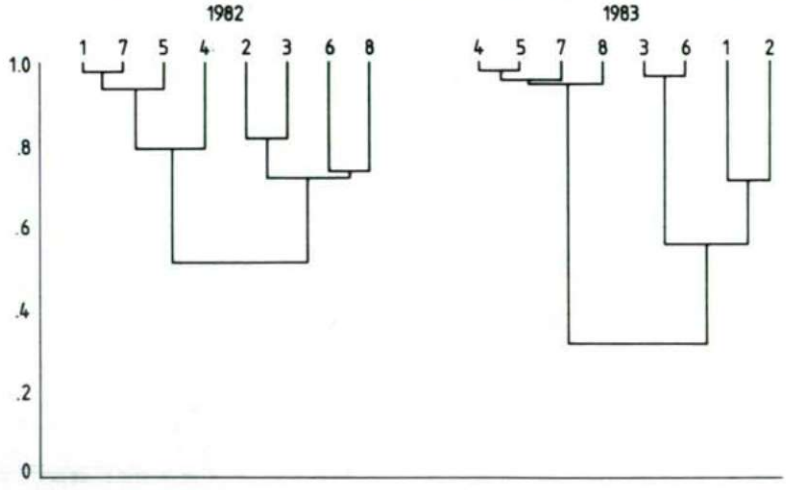

Fig. 3. Dendrogram of the 8 most frequent *Cicadinea* species on the basis of their distribution according to zonations. (The names of the species indicated by numbers are found in Table 6).

the latter occur at all three areas in varying ratio. The *Doratura homophyla* prefers the 1. area, the *Eurysa clypeata* and the *Psammotettix hungaricus* the 2. and 3. areas. The water perturbation did not give possibility for differentiation of such degree as in 1983, it developed between the species by means of the clearing the 3. level.

Since the *Cicadinea* is a uniform herbivorous group, it is necessary to study the vegetation at the three zonations for the explanation of the previously discussed distributions. The share in total coverage of the species found in the phytocenoses of the levels was regarded as a prime base for this (Table 7). Calculating RENKONEN index from this, it becomes evident that the vegetation of the 1. and 2. levels is similar in 63.7%, that of the 1. and 3. levels in 3%, and of the 2. and 3. in 3.2%. The high similarity of the first two levels is caused by the great dominance of the *Festuca pseudovina*, while the autonomy of the 3. level is due to the outstanding ratio of the *Puccinellia limosa* occurring elsewhere only in blades.

The similar values manifest in the case of the *Cicadinea* indicate the segregation of the very 1. level, thus the distribution of the *Cicadinea* cannot simply be explained by the distribution-relations of the plant species.

Table 7. Quantity of the various plant species from the total coverage at the three zonation levels

Species	Ratio of participation in total coverage		
	1.(D%)	2.(D%)	3.(D%)
Festuca pseudovina HAECKEL ap. WIESB.	50.0	75.0	–
Cynodon dactylon (L) PERS.	10.0	11.0	–
Trifolium campestre SCHREB.	20.0	4.0	–
Vicia lathyroides L.	4.0	0.5	–
Rhinanthus angustifolius GMEL. em. SOÓ	4.0	3.0	–
Lotus corniculatus L.	2.0	–	–
Allium vineale L.	0.5	–	–
Taraxacum officinale F. WEBER ex WIGGERS	0.5	–	–
Plantago lanceolata L.	3.0	–	–
Trifolium repens L.	1.0	–	–
Juncus gerardi LOIS.	2.0	–	1.5
Juncus compressus JACQ.	2.0	–	1.5
Poa bulbosa f. *vivipara* KOELER.	0.5	–	–
Muscari racemosum (L.) LAM. et DC.	0.5	0.2	–
Melandrinum album (MILL.) GARCKE.	–	0.2	–
Cerastium dubium (BAST.) O. SCHWARZ.	–	1.5	–
Spergularia marina (L.) GRISEB.	–	0.2	–
Plantago maritima L.	–	0.8	–
Puccinellia limosa (SCHUR.) HOLMBG.	–	1.2	93.0
Lepidium crassifolium W. et. K.	–	2.0	–
Veronica prostrata L.	–	0.2	2.0
Ornithogallum umbellatum L.	–	0.2	–
Aster pannonicus SOÓ	–	–	0.2
Carex distans L.	–	–	0.8
Eleocharis palustris (L.) R. et SCH.	–	–	0.2
Schoenoplectus tabernaemontani GMEL. PALLA	–	–	0.8

Now let's examine the development of the diversity values both in the case of the vegetation as well as the *Cicadinea* (Tables 8. and 9.).

Table 8. Cicadinea diversity-relations at the 3 zonation levels (spN: number of species; H'S: Shannon diversity value; J:evenness).

	1982			1983		
	1	2	3	1	2	3
spN	23	20	14	13	18	15
H'S	2.3525	1.4890	1.2045	2.1349	0.9296	0.8697
J	0.7503	0.4970	0.4564	0.8316	0.3216	0.3211

Table 9. Vegetation diversity-relations at the 3 zonation levels (spN: number of species; H'S: Shannon diversity value; J:evenness).

	1	2	3
spN	14	14	8
H'S	1.6481	1.0140	0.37358
J	0.6245	0.3842	0.179

Although the number of *Cicadinea* species are reather divergent at the various zonation levels in both studied years, the diversity and evenness relations showed similar development. At the highest relief the determinant factor of diversity is the even dominance-distribution. This may be in conformity with the similar composition of the vegetation. The low vegetation, the lack of shadowing effect, the higher salt-concentration of the host-plants caused by the more considerable withering result low average individual number.

The diversity of the vegetation at the middle area is smaller compared to the previous one, since the high dominance of the *Festuca pseudovina* decreases evenness. Therefore, — though the average individual number is the highest here, — the determinant role of the vegetation is seen from the medium diversity value.

With its lower plant-coverage, few plant species and periodical inundations, the lowest area provides the essential conditions for practically two leafhopper populations. The high dominance-ratio of these causes the lowest diversity value.

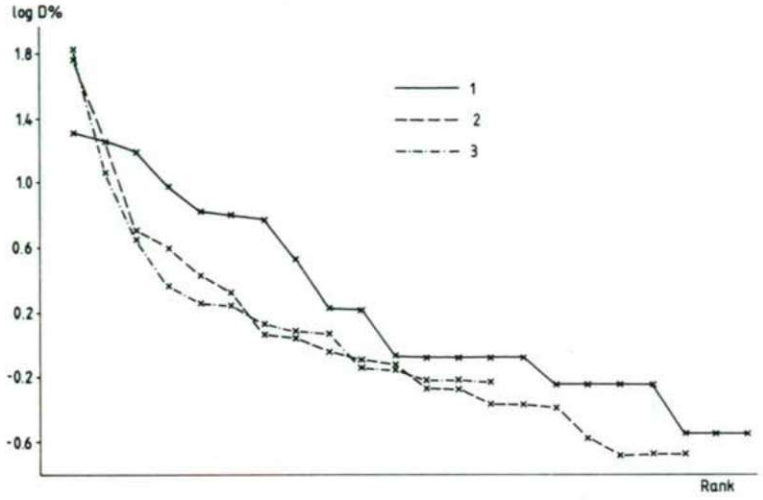

Fig. 4. *Cicadinea* dominance-diversity in 1982.

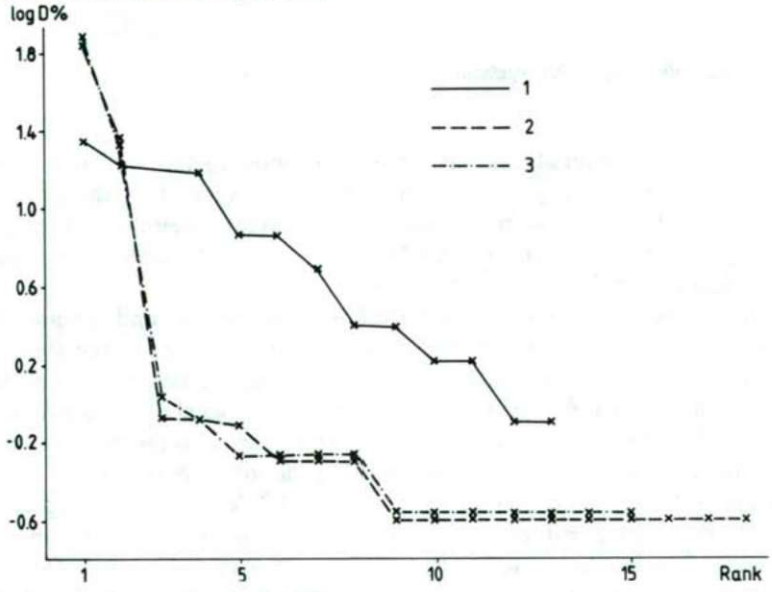

Fig. 5. *Cicadinea* dominance-diversity in 1983.

The dominance-diversity relations at the 2. and 3. areas are rather similar in the case of the *Cicadinea* (Figs. 4. and 5.). The dominating character of the 3. level is referred to by the fact that the two leafhopper species dominant here are also the dominant species at the 2. area, and when the structure of the 3. level was disturbed (in 1982), similar changes took place at the 2. level, too.

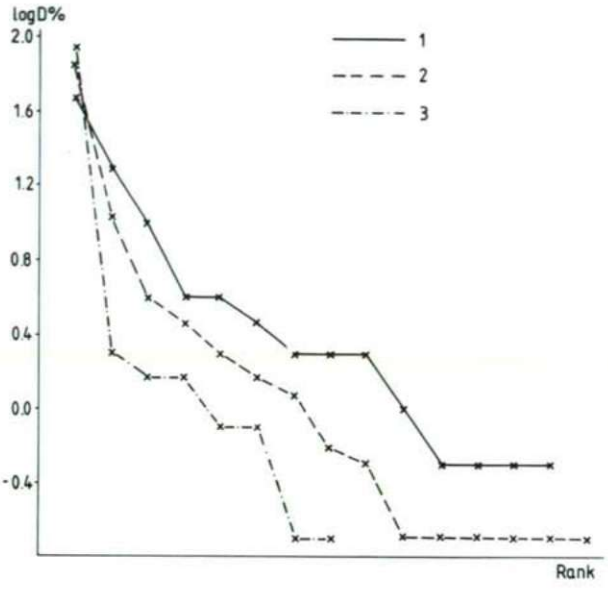

Fig. 6. Dominance-diversity of the vegetation.

The dominance-diversity curves only correspond to the similar curves of the vegetation in their tendency (Fig. 6). In the case of vegetation the ground water level appears to have significance as segregating factor. Therefore, it is not the 2. and 3. levels, but rather the 1. and 2. which stand closer to each other, similarly to those experienced for the RENKONEN index.

On the basis of the above, the *Cicadinea* distribution and diversity are not exclusively determined by the distribution and diversity, resp., of the vegetation. In our case — presuming o is partly the dominance, partly he chemical state of the host-plants, the latter influenced by the ground water level. This is proved by the fact that the *Cicadinea* communities of the 2. and 3. levels stand close to each other both regarding diversity and species-dominance-identity, despite that in the vegetation, the *Festuca pseudovina* dominant at the 1. and 2. levels would not give grounds for this. It is therefore presumable that the *Puccinellia limosa* may come into account as host-plant, besides the *Festuca pseudovina* — at least in the case of the *Eurysa clypeata* and *Psammotettix hungaricus*.

III. Seasonality study

To decide whether the leafhopper community living at the studied area forms seasonally segregated groups, dendograms were prepared from the similarity matrix between collecting time-points with the help of cluster analysis (by weighted average method).

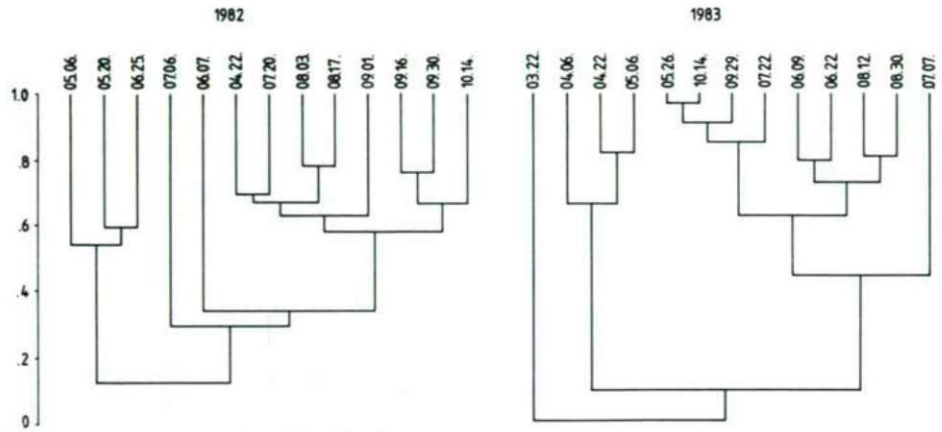

Fig. 7. Seasonality dendogram of the *Cicadinea* fauna at the 3 zonations in 1982–1983.

If examining the whole area, i.e. considering the average of the three levels (Fig. 7), similar dendograms are gained on the whole for both years. The fauna of the early spring, spring and (in 1982) the beginning of summer shows a loose, low-leveled linkage to the more uniform group of the end of June–November.

Since the similarity of the three levels to each other is rather divergent during the course of the year (Table 5), it is worth studying which is the most constant fauna among them, furthermore, what changes the fauna shows per level in the course of the season. For this, the values per level of the RENKONEN similarity indexes between the consecutive collections are presented, as the indicator of the fauna-constancy (Figs. 8–9).

In 1982, due to the long-lasting inundations there was no durable spring aspect either at the 3., or at the 2. areas (Fig. 8). This did not affect the driest 1. level to such a degree. Later, however, the faunas of the 2. and 3. levels are more constant, the summer and autumn aspects almost unite.

In 1983 the disturbing effect of the water did not prevent the development of the early spring, short, but highly continuous aspect at all three levels (Fig. 9). At the 1. level this is followed by the sharply segregated aspects of the beginning of summer and end of summer — autumn, with a slightly decreasing constancy level. The beginning of summer and end of summer — autumn aspects hardly show any segregation from each other at the 2. and 3. levels. The fauna at the 3. area is the most constant.

In order to learn whether the identical seasonality behaviour is the consequence of the identity of the fauna-composition, it is worthwhile to compare the previous presentation with the earlier discussed changes of the similarities found between the areas. It can be seen that according to the species-dominance-similarity the 1. area is only slightly similar to the other two, thus, e.g. it reaches the high spring aspect-constancy with an almost completely different fauna-composition than the

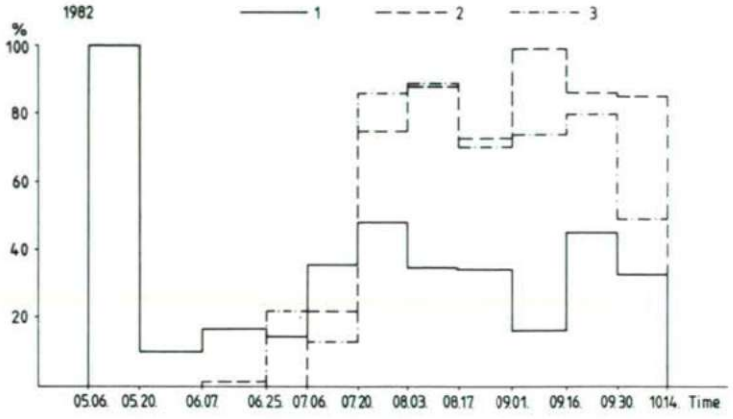

Fig. 8. Fauna-constancy of the *Cicadinea* fauna at the 3 zonations in 1982.

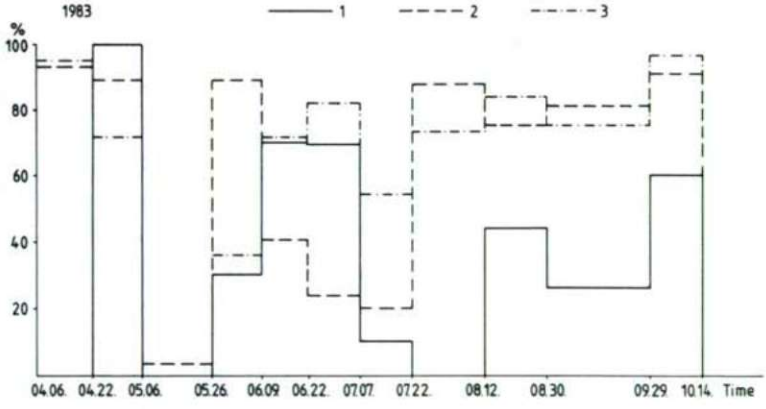

Fig. 9. Fauna-constancy of the *Cicadinea* fauna at the 3 zonations in 1983.

2,. and 3. levels. On the contrary, the faunas of the 2. and 3. areas are very similar in the periods of April–May and August–October, when this is caused by the similar behaviour according to aspects, while the faunas of the beginning of summer aspect are dissimilar.

In order to study the seasonal segregation of the 8 most frequent species a dendogram was constructed from the similarity matrix of their seasonal occurrence by cluster analysis (Fig. 10). It is clear from this that the seasonal segregation between

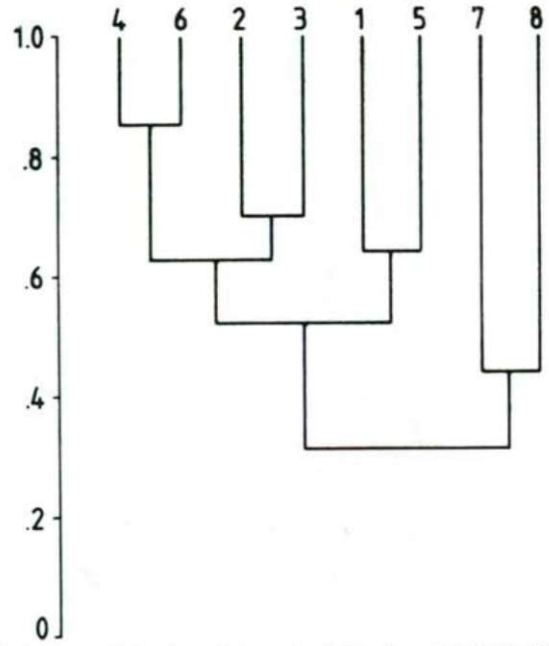

Fig.10. Seasonality dendogram of the 8 most important *Cicadinea* species in 1983. (The names of the species indicated by numbers are found in Table 6).

the species is much more characteristic than the segregation according to zonations (Fig. 3). The species dividing the area in similar manner (e.g. 4, 5, 7, 8) are much farther from each other in respect to seasonality.

By examining the season-dynamics according too species not only newer bionomic data are gained, but in the present case the seasonal changes in the attachment to the habitat can also be followed. According to the knowledge so far, from the dominating 8 species 6 winter in the form of eggs. Among them the *Recilia schmidtgeni*, *Deltocephalus pulicaris* and *Paluda vitripennis* are known as being of 2 generations; the *Toya minuscula*, *Doratura homophyla* and *Mendrausus pauxillus* as of 1 generation (SCHIEMENZ, 1969). Contrary to this, 2 generations were observable in the case of the latter species at the studied area (Fig. 11). The first generation developing from the overwintering eggs reaches its maximum at the beginning of June, the second at the end of September. It almost exclusively prefers the first level, only being found in low numbers at the other two areas as well in the period of the maximal individual density. Its host-plant, the *Festuca sulcata* (EMELJANOV, 1964), does not occur at the area, therefore it presumably consumes the *Festuca pseudovina* as well.

The *Paluda vitripennis* (Fig. 11) is quite similar to the former species both in respect to overwintering (MÜLLER, 1957) and generation-number (REMANE, 1958), but also regarding segregation per relief. Its host-plant is not known.

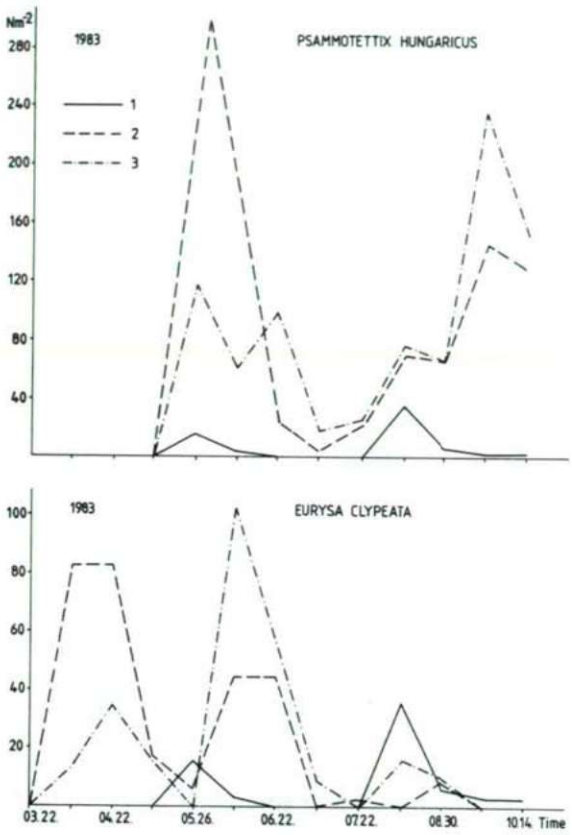

Fig.11. Changes in individual-density of the *Mendrausus pauxillus* and *Paluda vitripennis* in the 3 zonations in 1983.

In the case of the *Eurysa clypeata* and *Psammotettix hungaricus* neither the seasonal segregation, nor that of according to habitats are too significant in the annual average. The *Eurysa clypeata* (Fig. 12) is probably of 3 generations and overwinters in larval stage. Its first, early spring generation forms a maximum at the 2. area, the second, beginning of summer one at the 3. area. Its distribution greatly depends on the humidity relations. The *Festuca pseudovina* and *Puccinellia limosa* are with all certainty among its host-plants.

The *Psammotettix hungaricus* (Fig. 12) is of 2 generations, winters in the form of eggs. This is the species reaching the highest individual density. The maximum of its first generation partially coincides with the 2. generation of the *Eurysa clypeata*, only it is not dominant at the 3. area, but rather at the 2. one. The individual density of the second generation, however, is higher at the 3. area. Its host-plants are the *Puccinellia limosa* and *Festuca pseudovina*, as well.

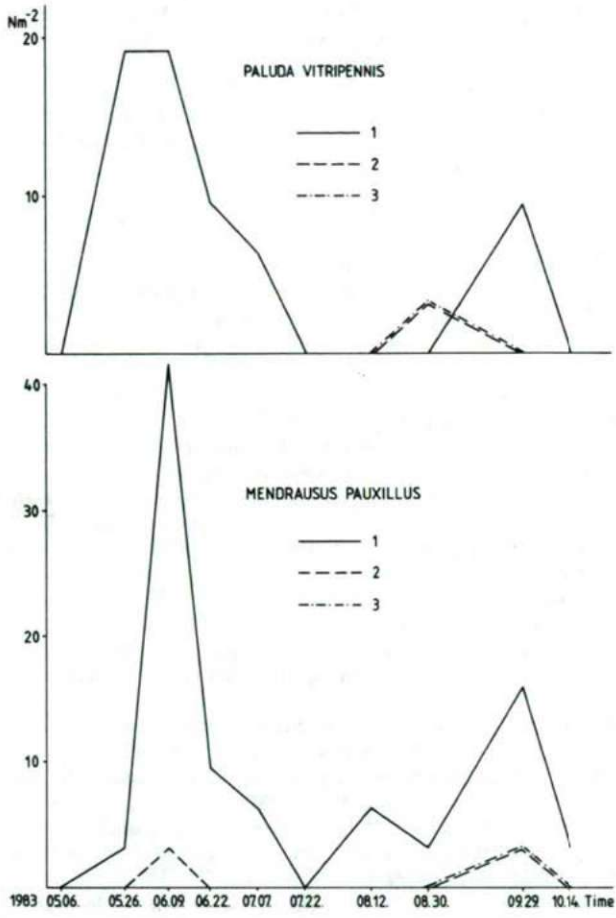

Fig.12. Changes in individual-density of the *Eurysa clypeata* and *Psammotettix hungaricus* in the 3 zonations in 1983.

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OCCURRENCE OF THALASSEMIA MAJOR ON A PALEOANTHROPOLOGICAL FINDING

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Abstract

The sign of severe anemic alterations were found on a child-skeleton excavated in Székesfehérvár street in Pécs (South–Transdanubia, Hungary) from a 109 tombed late-Roman cemetery detail. The morphological observation, X-ray picture of the bone alterations, as well as the light- and electronmicroscopic study of the samples gave the diagnosis of thalassemia major.
Key words: paleopathology, Roman age, bone lesions of anemia, thalassemia major.

Introduction

Since the time of its first thorough observation and description (HRDLIČKA, 1914), the syndrome called „symmetric osteoporosis" is much better known. COOLEY et al. (1927) made observations that characteristic deformations appear on the cranial and skeletal bones of children suffering from thalassemia major. Followings this, several excellent reviews were published by hematologists and radiologists, the purpose of which was firstly to ponder over the type, severity degree and therapeutic possibilities of the anemic alteration on the basis of the bone deformations (CAFFEY, 1937; MOSELEY, 1963; ASCENZI, 1976). The obtained observations were successfully used and are used by the specialists dealing with paleopathology, too, and are also utilized in the more exact diagnosis of the alterations of the bones originating from different archeological ages (HOOTON, 1930; MOSELEY, 1965; ANGEL, 1964; HENGEN, 1971). From the recent publications, the other pathological conditions accompanying anemic bone lesions (metopism, enamel-hypoplasia) and the joint importance of these are discussed in a paper by STUART–MACADAM (1985), who investigated the hygienic conditions of a population from the Roman age.

In the meantime, the molecular mechanism of the development of the various anemic alterations (thalassemia, sickle cell anemia) had been clarified, giving possibility for closer approach to the better treatment of the cases occurring even nowadays (HOLLÁN, 1972; NIENHUIS et al. 1979).

For the paleopathologist it is of particular importance to emphasize the interdisciplinary nature of the research, since only the consideration of the activities of the hematologist, radiologist and geneticist can lead to the better clarification of each diagnostic problem.

Material and method

The Archeological Department of the Janus Pannonius Museum in Pécs (South-Transdanubia, Hungary) performed rescue excavations conducted by an archeologist, ZSUZSANNA KATONA Győr between 1981–83 in the inner town of Pécs at the site of a demolished building in Székesfehérvár street. 109 graves were found at the area from the late-Roman age. The excavated cemetery part belonged to the graveyard of the civic town Sopianae. The cemetery has not been described in an archeological publication so far. The skeletons were studied from paleopathological and partly anthropological point of view in 1983–84 (SZALAI, 1984). In the simple earth grave no. 106 the devasted skeleton of a child was found. One part of it had been destroyed in the Middle Ages during the digging of a pit. The following bones reamined: skull bones broken to several pieces, but partially restorable; both upper jaws and cheek, lower jaw. The eruption of every deciduous tooth was observable in the teeth row archs, but 6 of them were lost postmortally. The exchange of teeth had not yet begun. From the postcranial bones, the remaining ones were the right side of the atlas, the axis without dens and five cervical fractions, 6 dorsal vertabral archs and 2 vertebral bodies, furthermore, 30 smaller-larger rib fractions, both clavicle, the right-sided scapula, right-sided humerus, ulna and radius.

The sex could not be determined, because of the young age. On the basis of the dentition (SCHOUR and MASSLER, 1941) and taking the ossification table into account (SCHINZ et al. 1952), the age of death could be estimated between 2.5–3.5 years. Only a bronz coin furniture from the Roman Age was found in the oral cavity of the finding, which coloured the surrounding bones green.

Morphological alterations referring to generalized benign bone-marrow hyperplasia could be observed on the skeleton of the grave no. 106. Following the detailed macroscopic morphological description of them, the skull bones and the scapula were studied by X-ray as well. For electronmicroscopic study 5x5 mm sized, 2–3 mm thick slices were sawn from the pathological bone surfaces of the skull. Following soaking in 96% alcohol for one day and cleaning, the samples were steamed with gold layer in rotation apparatus, then studied under JEM 100 B scanning electronmicroscope on the basis of the experiences by HARSÁNYI et al. (1978). Samples taken from the macroscopically intact surface of the skull served for comparison. The photographs were prepared at a magnification of 1000x. After previous decalcination, sections were prepared from the bones for light microscopic studying, too.

Description of alterations

The alteration at first called „symmetric osteoporosis" has charasteristic, easily recognizable symptoms. The elemental phenomena of the alteration are formed by the followings: owing to the hyperplasia of the bone marrow occupying the fungous substance, the cortex becomes extenuated (Fig. 1a), then by dilating the physiologically also present small gaps the bone marrow reaches beneath the periosteum. By further spreading, the bone marrow strains the periosteum, which induces secondary bone formation along the dilated gaps. The septum-like, small bone increments protrude from the bone surface perpendicularly and construct a brush-like formation as observed in other cases, too (ASCENZI, 1976; MOSELEY, 1965).

These characteristic symptoms of benign marrow hyperplasia could also be determined on the skull and postcranial skeleton parts of the child skeleton from the grave no. 106. The alterations were detectable both on the ecto- and endocranial surfaces of the skull, firstly restricted to the frontoparietal region (along the tubera frontalia, squama frontalis, tubera parietalia, sutura sagittalis), but also on the squama occipitalis. At the mentioned places the smooth bone surface was found to be thickly pierced by roughly circular, small (with diameters of 0.5–1–2 mm), sharp

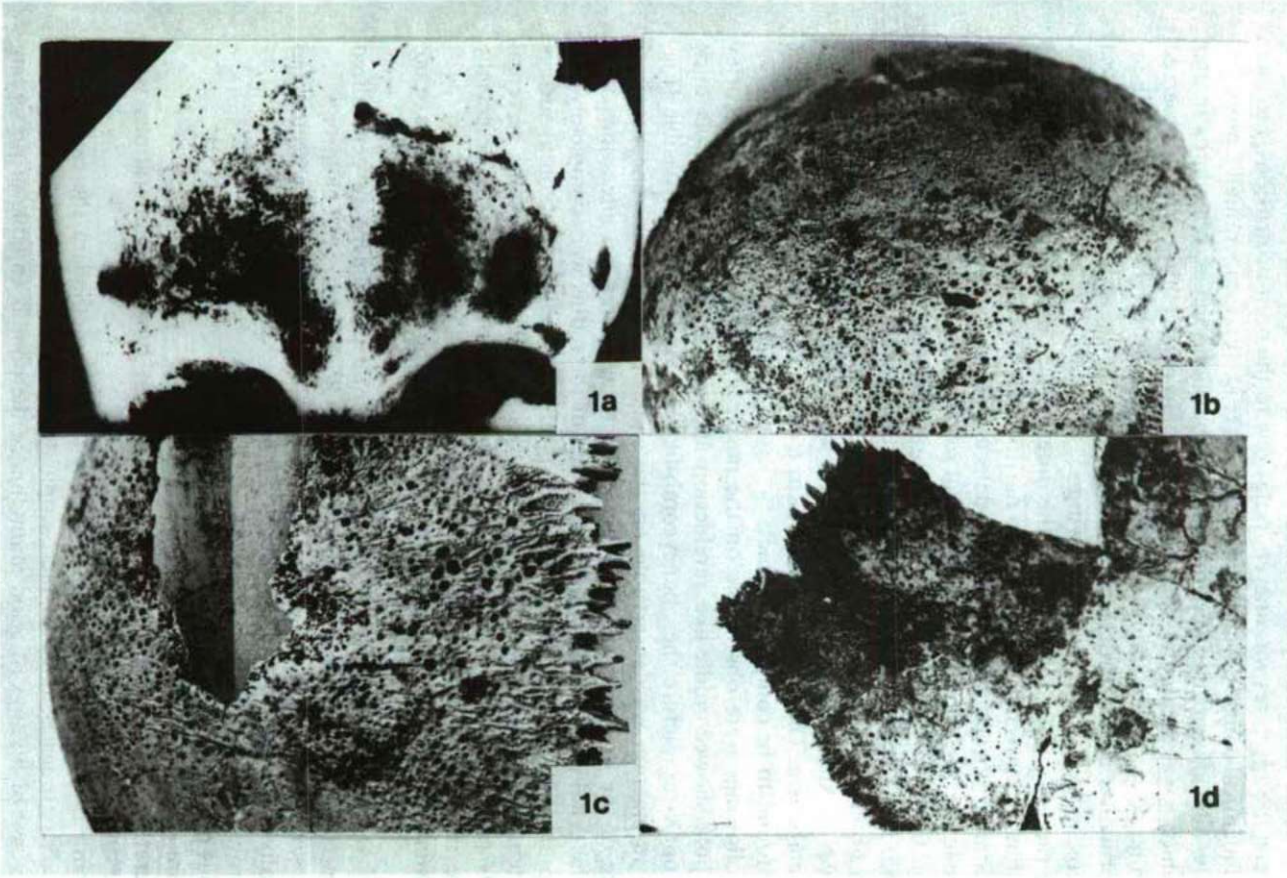

Fig. 1a. The expansion of the diploe space and the thinning of the cortex are well visible on the X-ray picture of the frontal bone
Fig. 1b. The ectocranial surface of the frontal bone with the signs of osteoporosis and hyperostosis
Fig. 1c. The ectocranial surface of the parietal bone with the formation of channels and passages
Fig. 1d. Moss-like, undulatory bone-laths are observable on the endocranial surface of the parietal bone

edged apertures (Fig. 1b). The brim of the apertures sharply protruded in a funnel-like manner at places, which made the bone surface rough to the touch. The space between the apertures was uneven, bulgy due to the brim-protrusions, furrows, passages of identical course developed on the vault (Fig. 1c). Endocranially, however, there not the dilated apertures were dominating, but bone-spines, bone-laths similar to moss, which have undulatory course (Fig. 1d). No rarefaction could be observed on the lamina frontalis bordering the orbit from above. Rarefaction and bone-increment formation could be detected on the corpus of the sphenoid, in the fovea hypophyseos, as well as on the greater wings.

Bone rarefaction was observed on the outer surface of both upper jaws of the skull, too, but the sinus maxillae were also narrowed down by long, sharp, spine-like exostosis. Similar porotic alterations were detected on the ascending ramus on both sides of the lower jaw, as well as on its mental section. The teeth are specially worth mentioning. Caries could be seen on the occlusal surface of all four second molar teeth (55, 65, 75, 85), probably also being in connection with the basic disease causing the lesions observable on the bones. The alterations affecting the teeth as well are presumptive of such a metabolic disorder which also had influence on the calcium-metabolism. The rest of the deciduous teeth and the germs of the permanent teeth were found to be completely intact.

The followings were observable on the postcranial skeletal bones: the cortex of the scapula showed riddle-like rarefaction and thinning, its spongy was thick (Fig. 2a), on X-ray picture the „honeycomb-like" structure was well visible (Fig. 2b). Bone rarefaction was observable on the ends of the clavicle. The proximal end-surface of the humerus was thin, spotted with apertures, no alterations were found at the distal part. The ulna and the cortex of the radius were completely free from symptom. The arch of the examinable vertebra as well as the frontal surface of the vertebral bodies were also found to be thinner. The height of the vertebral bodies was proportional, without any signs of compression. The ribs, especially around the angle, were thickened, deformed.

As a summary, the followings could be found on the skeleton of the grave no. 106.:

- very severe bone rarefaction with the elemental phenomena of generalized benign bone marrow hyperplasia on the bones of a 2.5-3.5 years old children;
- the same appeared on the skull with frontoparietal dominance (ecto- and endocranially);
- narrowed down sinus maxillaris;
- caries on all four second deciduous molars;
- cribra orbitalia could not be observed;
- alteration was more characteristic on the flat bones, no alterations were observable on the surfaces bearing the cartilage.

Scanning electronmicroscopy (SEM) is a suitable method in the cases when surface studies are necessitated in microscopic dimensions.

In the case of findings of good maintenance the bone is capable of preserving the alterations originating from disease, injury for as long as several thousand years,

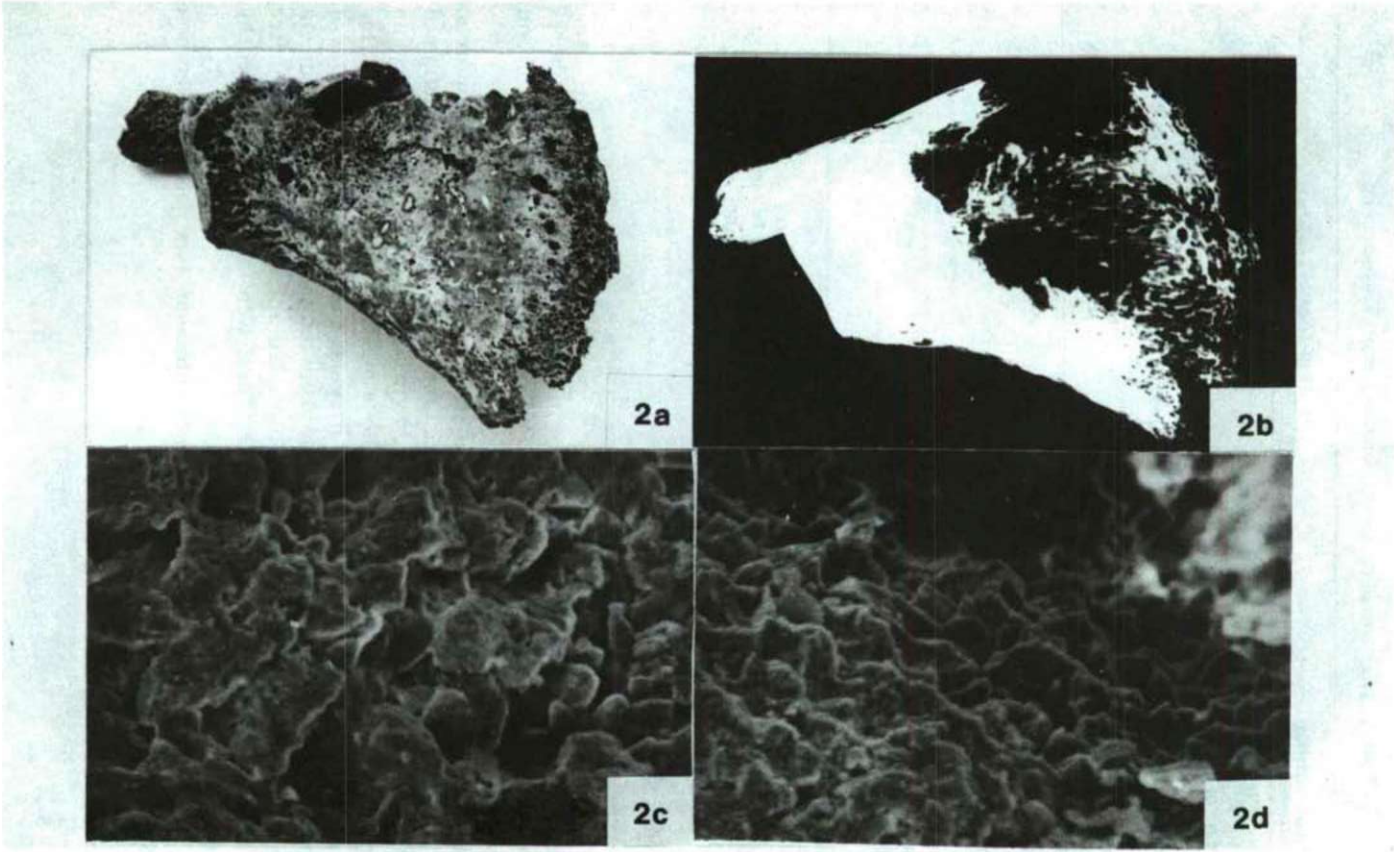

Fig. 2a. Porotic facies costalis of scapula
Fig. 2b. „Honeycomb-like" contour is recognizable on the X-ray picture of the scapula
Fig. 2c. SEM picture of osteoporotic skull surface with lump-like ossificational centres (1000x)
Fig. 2d. Small, conoidal exostoses are detectable on the SEM picture of intact skull surface (1000x)

Table 1. Symptoms of diseases causing bone marrow hyperplasia

Symptoms, characteristics	Types of diseases						Grave no. 106
	1.	2.	3.	4.	5.	6.	7.
Below 5 years of age	+	+	+	±	±	+	+
Severe bone lesions	+	+	–	–	–	–	+
Frontoparietal skull deformation	+	+	+	–	+	+	+
Occipital skull deformation	–	–	–	+	–	–	–
Presence of cribra orbitalia	±	±	–	+	–	–	–
Deformation of cheek	+	±	–	–	–	–	+
Narrowed down sinus maxillae	+	–	–	–	–	–	+
Disorder of postcranial bones	+	+	±	±	–	+	+
Bone-infarctions following thrombosis	–	+	–	–	+	–	–
Vertebral body compression	–	+	–	–	–	–	–
Bone deformation around the elbow-joint	–	–	–	+	–	–	–
„Honeycomb-like" bone structure on X-ray picture	+	–	–	–	–	–	+

Explanation of labellings :

+ the observed characteristic occurs
± the observed characteristic may be rarely occur
– the observed characteristic does not occur

The names of the diseases-types no.1.–6. see in the text.

even at microscopically. This gave the notion to perform SEM studies on bones originating from archeological excavations (HARSÁNYI, 1977; MARCSIK et al., in press).

SEM studies were also carried out on the sample sawn out of the osteoporotic surface of the parietal from the grave no. 106. On this basis it could be determined that apertures dilated in funnel-like manner led to the bone surface from the direction of the diploe, and in these the hyperplastic bone marrow was pushed beneath the periosteum. Due to the periosteal irrigation, irregular shaped, lump-like centres of ossification were detectable on the bone surface between the apertures (Fig. 2c). On a picture of the same magnification, only pin-pricked apertures led to the surface on the sample taken from the intact surface. These were made finely uneven by small, conoidal exostoses (Fig. 2d).

The observed phenomena indicated the trabecular type of the alteration (MARCSIK and KÓSA, 1976).

Discussion

The amount bone marrow increases in every case when the oxygen demand of the tissues is considerably and long-lastingly greater than that of the erythrocytes can provide. The decrease in the average life span, or the pathological hemoglobin content of the erythrocytes, furthermore, their vitamin B_{12} and iron deficiency all lead to compensatory bone marrow proliferation. This compensates the hypoxia of the tissues with enhanced erythropoiesis. In infancy and early childhood the enhanced erythropoietic function is taken over by the enlarged liver and spleen as well as by the overgrowing bone marrow found in the spongy of the skull and the other bones. The question is, which diseases in childhood may lead to bone marrow hyperplasia accompanied by enhanced erythropoiesis?

Taking the opinion of MOSELEY (1965) into account the following diseases may be considered to be important:
1. thalassemia major. 2. sickle cell anemia, 3. hereditary spherocytosis, 4. iron deficiency anemia, 5. heart diseases accompanied by cyanosis, 6. polycythemia vera.

The alterations characteristic of the various diseases are summerized in Table 1. on the basis of reference works (MOSELEY, 1965; ASCENZI, 1976; STEINBOCK, 1976). The serial number 7. indicates the child skeleton under discussion. The table also demonstrates the lack or presence of a character in diseases already known and labelled by previous serial numbers, as well as in the case of the bone deformation of the grave no. 106 of unknown origin.

On the basis of the described morphological phenomena and the comparison with other diseases, the pathological alteration of the skeleton from the grave no. 106 excavated in Székesfehérvár street in Pécs can be diagnosed as thalassemia major. Apart from the morphological signs, the geographical-hematological data also refer to thalassemia. The finding originates from the Roman Age for certain, and according to archeological data (FÜLEP, 1969) there were also families among the inhabitants of the town Sopianae, who had settled down here from Italy. The homozygote form of thalassemia is known both from historical ages as well as in the populations of today, firstly from the region of the Mediterranean.

Our case proves that the paleopathological studies may provide data to the clarification of a population's migration, too.

Thanks are due to archeologist ZSUZSANNA KATONA Győr for permitting the publication of the finding, furthermore, to professor LÁSZLÓ HARSÁNYI for his manifold professional support, to KÁROLY TROMBITÁS, head of laboratory, for the preparation of the electronmicroscopic pictures, JÓZSEF MOLNÁR, assistent lecturer, for the preparation of the X-ray pictures, and to MRS. SZABÓ, ZSUZSA CSERI, for the photographs.

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COMPARISON OF SOMATIC CHARACTERS IN MENSTRUATING AND NON-MENSTRUATING GIRLS

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(Received: August 30, 1985)

Abstract

Authors compared the means of body height, body weight, chest circumference on normal breathing and biiliac diameter, as well as the standard ranges of them, resp., in the case of over 20 thousand 10.5–15.5 year old menstruating and non-menstruating girls. It was determined that the lower and upper end values of the standard ranges were higher for the menstruating girls in the case of every character.

Key words: menstruating and non-menstruating girls, body height, body weight,chest circumference, biiliac diameter.

Introduction

Among the factors influencing the puberty of girls, as well as the factors connected with this, the body measures are also frequently taken into account by the various authors. From these the body weight is considered to be a character of emphasized importance.

One part of the publications stresses that the body weight of menstruating girls is higher in comparison to their non-menstruating companions of similar age (CSÓKA et al. 1981; FARKAS and SZEKERES, 1982). This determination is firstly results from the comparison of the arithmetic means and is an obvious phenomenon if taking into consideration that the puberty of girls is preceded by the peak hight velocity.

The other part of authors approach this question from another side, referring to the fact that the girls of greater weight menstruate earlier than those of less weight (KANTERO et al. 1970; RICHTER, 1973), resp., the menarche starts sooner in the case of fatter girls than thinner ones (ŠELAKOVIĆ and BURKA, 1978). Others have found that the menstruation starts in precox majority in obese girls (VESIĆ et al. 1978). There are also data pertaining to the menarche-retarding effect of thinness and intensive sport activity (VANDENBROUCKE et al. 1982).

FRISCH had linked the starting of menarche directly with a critical body weight, which he determined as 47.8 ± 0.5 kg (FRISCH, 1974). This conclusion, however, has been disputed by many (FARKAS and SZEKERES, 1982; PESTHY, 1984).

Those authors who either link the appearance of the menarche to a defined body weight, or speak of the greater weight of those menstruating do not emphasize the followings:

1. The statements are mostly based on the comparison of the arithmetic means, which point out the common features but conceal the individual cases.

2. In the case of menstruating, the higher arithmetic mean is in tight connection with the peak hight velocity.

3. There are girls — not so few in number — who do not reach the indicated critical body weight, still the menarche appears and, resp., the menarche does not regularly start in the case of girls of greater weight, either.

4. The race is completely left out of consideration when determining the critical body weight. It is not likely that the critical body weight given by FRISCH would be applicable for example to the Vietnamese, Laotian, Korean, or very low negritid girls.

Therefore, we feel that the connection between the body measures and the appearance of the menarche needs more exact explanation.

Sample and method

In an earlier paper one of the present authors had expounded in detail the data collection performed between 1981 and 1984 concerning the factors influencing the puberty of Hungarian girls (FARKAS et al. 1983). On the basis of this work, possibility is also open for dealing with the question of the connection between the body measures and the menarche, and menstruation, resp., on the basis of a survey on a high number of sample elements.

In order to approach the problem four body measures of girls belonging to the age group of 10.5–15.5 years were taken as a base (body height, body weight, chest circumference on normal breathing, biiliac diameter). From the individual data evaluated with an R–55 type computer, the sample size (n), arithmetic means ($\bar{x}$) and standard deviation (s) according to age groups are at our disposal. These parameters are shown in Tables 1. 4. in the case of menstruating and non-menstruating girls according to age groups and characters.

Table 1. Parameters of body height for menstruating and non-menstruating girls

Age	Menstruating girls			Non-menstruating girls		
	n	$\bar{x}$	s	n	$\bar{x}$	s
10.5	27	151.5	6.63	1413	141.3	6.65
11.0	85	152.5	6.58	1784	144.1	6.83
11.5	212	154.9	5.98	1826	146.5	6.97
12.0	470	155.6	5.99	1448	149.1	6.93
12.5	851	156.5	5.98	1179	151.3	6.77
13.0	1173	157.7	6.12	857	153.2	6.67
13.5	1523	158.7	5.99	480	154.6	7.06
14.0	1676	159.5	5.96	275	156.6	6.84
14.5	1845	159.9	5.94	127	156.7	6.15
15.0	2085	160.8	5.99	50	158.3	7.46
15.5	1887	160.9	5.94	17	158.3	8.22
Total:	11834			9456		

Table 2. Parameters of body weight for menstruating and non-menstruating girls

Age	Menstruating girls			Non-menstruating girls		
	n	$\bar{x}$	s	n	$\bar{x}$	s
10.5	27	48.7	10.34	1413	35.1	7.22
11.0	85	47.8	9.75	1784	36.8	7.76
11.5	212	48.9	8.57	1825	38.6	8.52
12.0	470	49.7	9.06	1448	40.3	8.07
12.5	852	50.5	9.08	1179	41.7	8.31
13.0	1172	50.4	8.28	857	42.5	7.98
13.5	1523	51.8	9.38	480	43.0	7.50
14.0	1675	52.2	8.67	275	44.4	7.65
14.5	1846	53.7	8.94	127	45.4	8.48
15.0	2077	54.5	8.68	50	46.3	7.19
15.5	1883	55.0	8.24	17	46.5	8.08
Total:	11822			9455		

Using the arithmetic mean and the standard deviation so-called standard ranges were formed according to age groups (standard range = $\bar{x} \pm 1.96s$) for each character in the case of menstruating, and not yet menstruating girls. The standard ranges formed in the above manner are shown according to characters in Figs. 1.–4.

Table 3. Parameters of chest circumference on normal breathing for menstruating and non-menstruating girls

Age	Menstruating girls			Non-menstruating girls		
	n	$\bar{x}$	s	n	$\bar{x}$	s
10.5	27	80.0	8.18	1413	67.0	6.67
11.0	85	79.3	8.22	1784	68.5	7.00
11.5	212	79.9	7.65	1825	70.2	7.64
12.0	470	80.6	7.45	1448	71.7	6.95
12.5	851	81.5	7.43	1179	73.2	7.12
13.0	1170	81.3	6.90	857	73.8	6.79
13.5	1524	82.6	7.75	480	74.5	6.37
14.0	1676	82.8	7.08	275	75.5	6.16
14.5	1846	84.3	7.34	127	77.6	7.83
15.0	2084	84.9	6.88	50	77.6	6.05
15.5	1887	85.3	6.78	17	79.0	6.78
Total:	11832			9455		

Table 4. Parameters of biiliac diameter for menstruating and non-menstruating girls

Age	Menstruating girls			Non-menstruating girls		
	n	$\bar{x}$	s	n	$\bar{x}$	s
10.5	27	25.0	1.51	1412	22.3	1.55
11.0	85	24.8	1.82	1783	22.8	1.61
11.5	212	25.2	1.56	1820	23.2	1.70
12.0	469	25.4	1.62	1447	23.7	1.63
12.5	851	25.6	1.61	1179	24.2	1.67
13.0	1169	25.9	1.55	856	24.5	1.67
13.5	1511	26.1	1.66	477	24.7	1.68
14.0	1664	26.3	1.60	273	25.0	1.57
14.5	1841	26.6	1.65	125	25.3	1.69
15.0	2084	26.8	1.58	50	25.8	1.57
15.5	1883	27.0	1.58	17	25.6	2.13
Total:	11796			9439		

Observations were only made from the 10.5 year age group during the analysis, since the number of those already menstruating among the younger girls is extremely low. On the other hand, the girls older than 15.5 years were not taken into consideration because in this case the number of those not yet menstruating is few, and thus even the somatic data related to them can be regarded to be unreal. Even besides such approach our observations concern more than 20 thousand girls.

The differences between the arithmetic means per character of the menstruating and non-menstruating girls were checked by two-sampled Student's test.

More detailed information regarding the techniques of the data collection are comprised in earlier publications (FARKAS et al. 1983).

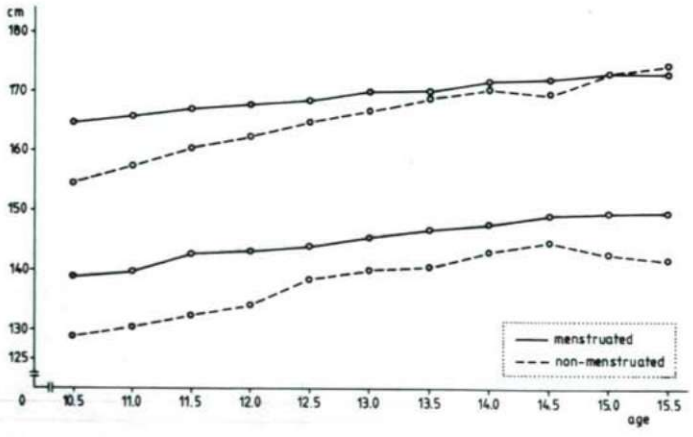

Fig. 1. $\bar{x} \pm 1.96.s$ interval of the body height of menstruating and non-menstruating girls

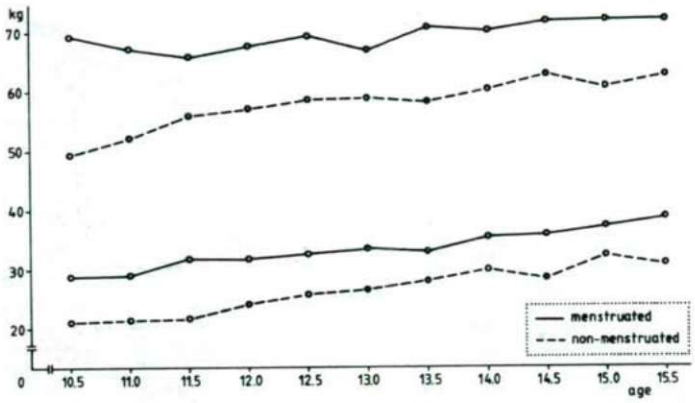

Fig. 2. $\bar{x} \pm 1.96.s$ interval of the body weight of menstruating and non-menstruating girls

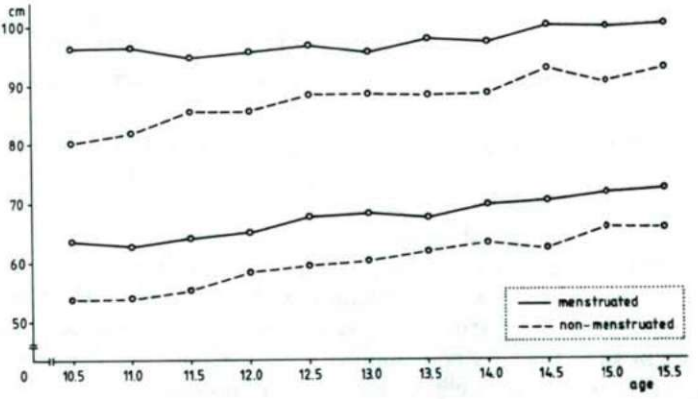

Fig. 3. $\bar{x} \pm 1.96.s$ interval of the chest circumference on normal breathing of menstruating and non-menstruating girls

Results

It is clear from the comparison of the arithmetic means shown in Tables 1.–4. that for all four characters and every age group the mean values of the menstruating girls are essentially higher.

With two-sampled Student's test the deviation between the means of the two part-samples could only be verified at 90% probability level in the case of the body height of the 15.5 year old girls, while in the rest of the cases and age groups the means of the body measures for the girls already reaching puberty proved to be

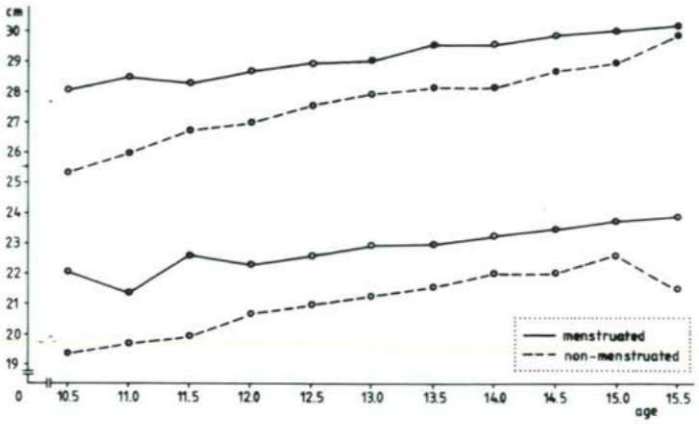

Fig. 4. $\bar{x} \pm 1.96s$ interval of the biiliac diameter of menstruating and non-menstruating girls

higher at a probability level of 98–99.9%. In the case of the 15.5 year old girls this exception can be explained by the low number of the non-menstruating girls as well as the relating high dispersion value.

Thus the observation that the means of the body measures of the girls already reaching puberty are higher than the ones not reaching puberty yet can practically be supported on the basis of the arithmetic means.

In the case of the standard ranges formed with the help of the arithmetic means and the standard deviations, the lower and upper end values of the standard ranges ($=\bar{x} \pm 1.96s$) regarding the menstruating girls are higher than the respective parameters of still not menstruating girls in case of every character and each age group. This can by no means be explained by the standard deviations, since these are higher concerning body weight and chest circumference on normal breathing, and are lower regarding body height in every age group of the already menstruating girls, contrary to those not menstruating yet. In respect to biiliac diameter, the standard deviation values for the menstruating girls aged 11, 14 and 15 were found to be higher, and in the rest of the age groups lower compared to the girls not reaching puberty yet.

Similarly to the arithmetic means, the standard deviation, in standard ranges of the two groups are evidently in connection with the peak hight velocity.

In respect to the body weight, on the basis of our studies such high values for this measure were found in every age group of the non-menstruating 10.5–14 year old girls which even suppassed the upper limit of the standard range for the already menstruating girls.

At the same time, such minimal body weight occurred in the 15 year old age group of the menstruating girls, which is fell below the lower value of the standard range for the girls not reaching puberty yet.

If we accept the assumptions that

1. puberty is restricted to a critical body weight, and

2. the girls of greater body weight reach puberty sooner than those of less weight,

then apart from the very high body weight, no explanation could be given to the lack of the menarche in the case of the 10.5–14 year old non-menstruating girls.

According to our judgement, therefore, it is completely incorrect to restrict the time-point of puberty to a defined body weight, and in general, only to the body weight. These conspicuous cases unambiguously support that the neuroendocrine system has great effect on the beginning of puberty, since the somatic characters are not only influenced by the neuroendocrine effects, but also to a great extent by the environmental factors.

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CHANGES IN THE SOMATIC CHARACTERS OF 10–18 YEARS OLD HUNGARIAN STUDENTS ACCORDING TO SETTLEMENT SIZES

GY. FARKAS and T. TAKÁCS

(Received: August 30, 1985)

Abstract

Authors studied the body height, body weight, and chest circumference on normal breathing of 20585 boys and 28128 girls. The conclusion could be drawn that with the two-sample Student's test, demonstrable deviation between the body measurement means of 10–18 years old youth living at settlements of different size could only be detected in 16.4% of the cases to the benefit of those living at larger settlements.

The results are based on the data pertaining to Hungarian students examined between 1981 and 1984 and originate from a cross-sectional growth studies.

Key words: physical development, settlement size

Introduction

Between the two world wars an increase in the mean values of the somatic characters — body height, body weight, chest circumference of the youth — was observed. In special literature this phenomenon is called acceleration according to BENNHOLDT–THOMSEN (1941).

The observations from different countries verify that this phenomenon is unambiguously demonstrable independent of the ethnical groups. The factors which can be brought into connection with accelaration have been divided into two groups by GRIMM (1966). Among others, this author mentioned the effect of urbanization as well. The causes of the increase in body measurements of the youth, however, cannot unambiguously be explained by one of the many factors, or by the joint effect of several ones. Nevertheless, without a doubt the living standards of a given population, the state of development of a society, the improvement of the hygienic conditions, and in general, the environmental factors may all play significant role in it.

On the basis of all these it may be more correct to accept the opinion according to which one should speak of the decrease of the effect of the factors inhibiting the development of youth, i.e. the degree of retardartion, rather than of acceleration (VÉLI, 1972).

Even among the Hungarian studies on body growth we can find evidence of the fact that the body measurements of students of the same age and sex living at

larger settlements are higher compared to those living at smaller settlements (RAJKAI, 1951, 1959; EIBEN, 1956; FARKAS, 1961). However, the question arises, whether these differences between the body measurement means of youth living at settlements of different size can be observed nowaday or not.

We wish to provide newer data to decide this question, on the basis of our recent studies.

Sample and method

Between 1981 and 1984, during the course of studies on the factors influencing the puberty of girls, we had opportunity to study the somatic characters pertaining to 32156 girls and 22898 boys. The body measurements were determined by the method of MARTIN (MARTIN and SALLER, 1956). The measurements were specified in case of every person by the same scientist, using Harpenden-type anthropometer, steel measuring tape, calipers and medical scales (with accuracy of 50 g). In this way we wished to avoid the methodologic error which could be caused by various techniques of measuring. The data collection was related first of all to the 10–18 years old age group, although studies were also performed on students of younger age as well as on nursery-school children. The domicile of the students was also recorded while collecting the data, which was grouped into one of the followings, taking the census data into consideration:

(0) — settlement with 100–200 thousand inhabitants,
(1) — settlement with 50–100 thousand inhabitants,
(2) — settlement with 10–50 thousand inhabitants,
(3) — settlement with 5–10 thousand inhabitants,
(4) — settlement with less than 5 thousand inhabitants.

Since the sample size was rather high, it was possible to comparing the body measurement means of the students living at the settlements of various size.

The most important parameters (sample size, arithmetic mean, standard deviation, range) were calculated from the basic data with R–55 type computer according to half-year age groups formed on the basis of the IBP's decimal age-table, at the László Kalmár Cybernetic Laboratory of the Attila József

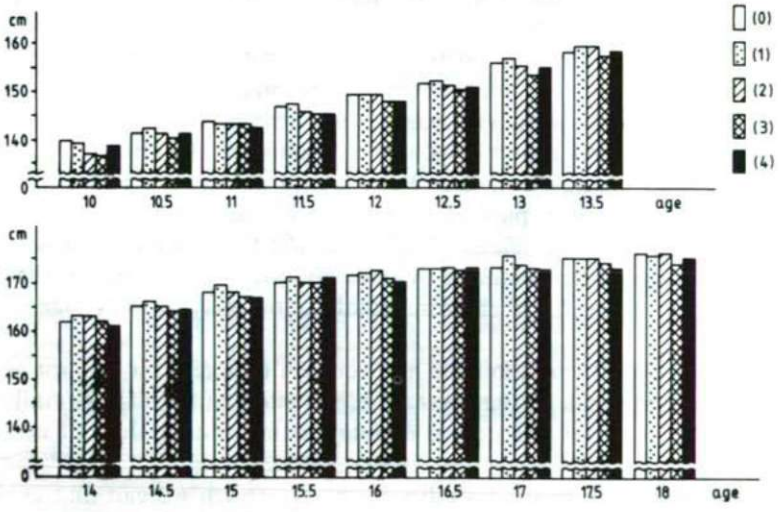

Fig. 1. Body height means for boys according to the size of their domicile

University. The authors hereby wish to express their sincere thanks to PÉTER HUNYA, ISTVÁN HERENDI, ZOLTÁN VAS and DIETMAR GRÖGER, cybernetics, for their help with data processing.

In Figs. 1.–6. the means of body height, body weight and chest circumference on normal breathing are demonstrated according to half-year age groups between 10–18 years of age, on the basis of the above-mentioned five settlement groupings.

At the same time it was also verified by two-sample Student's test whether the differences manifested between the means of the certain somatic characters regarding the students of the same sex and age, grouped into the two-two different settlement categories could be statistically demonstrated. Ten settlement-pairs could be formed on the basis of the five settlement groups (e.g.: (0)–(1), (0)–(2), (1)–(2)

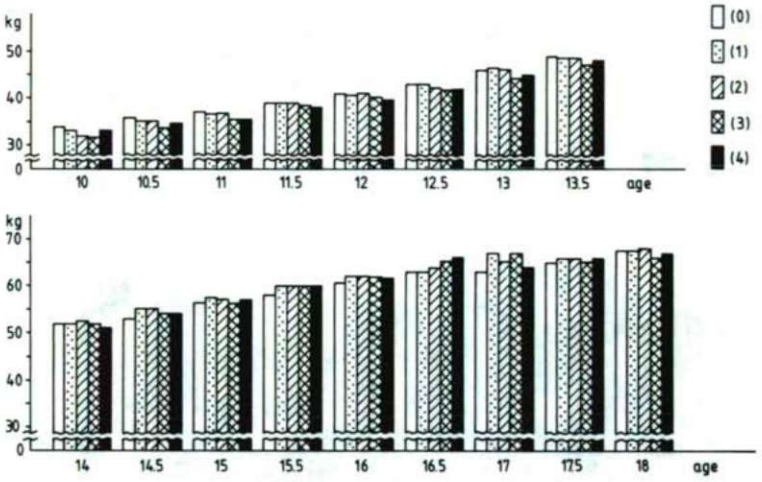

Fig. 2. Body weight means for boys according to the size of their domicile

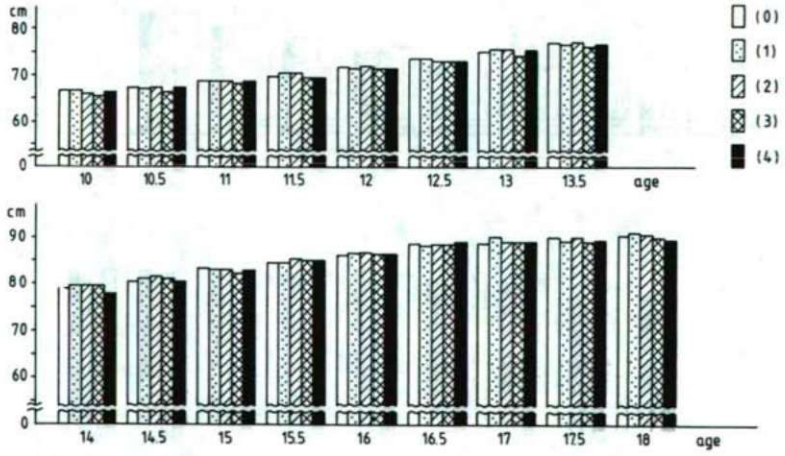

Fig. 3. Chest circumference means on normal breathing for boys according to the size of their domicile

etc.), which resulted a total of 170 combinings according to character, taking the number of age groups into consideration. Table 1. presents separately, according to character the number as well as relative frequency of those cases in which the results of the Student's test the deviations between the arithmetic means in the case of the settlement pairs at the probability levels lower than 95%, of 95% and higher than 95%.

The deviations verified at the probability level of 95% or higher mean that the body measurement means for the students living at larger settlements are statistically higher than that of the students living at smaller settlements.

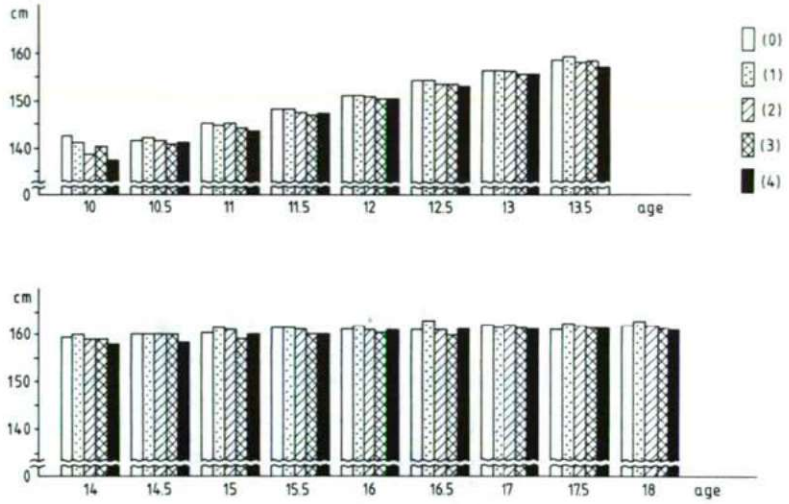

Fig. 4. Body height means for girls according to the size of their domicile

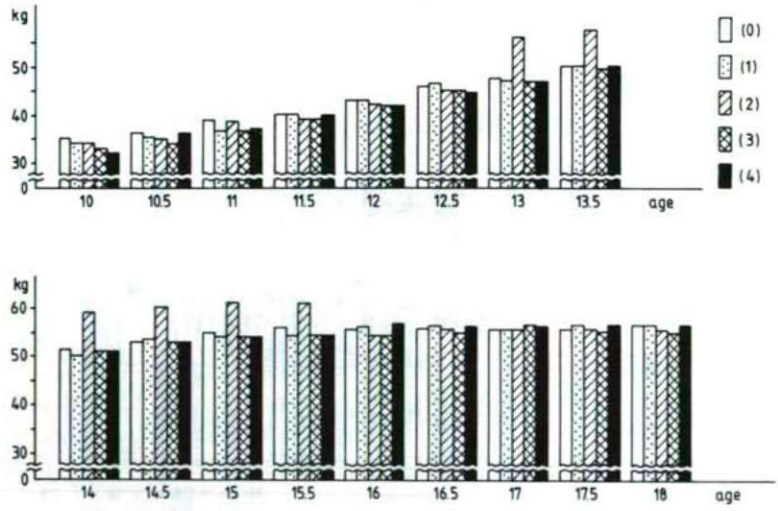

Fig. 5. Body weight means for girls according to the size of their domicile

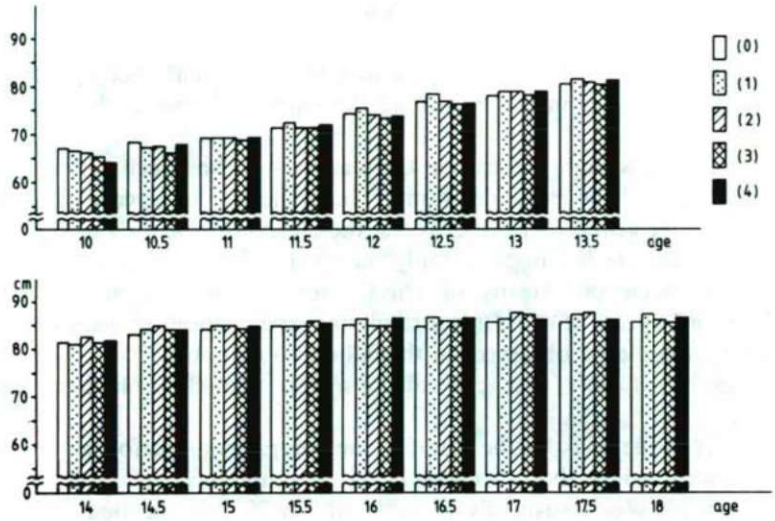

Fig. 6. Chest circumference means on normal breathing for girls according to the size of their domicile

Table 1. Frequency of occurrence of probability levels according to sex and characters

Character	Significance							
	To the benefit of larger settlement						To the benefit of smaller settlement	
	p<95%		p=95%		p>95%			
	n	%	n	%	n	%	n	%
a/ Boys								
Body weight	142	83.5	10	5.9	9	5.3	9	5.3
Body height	124	72.9	17	10.0	26	15.3	3	1.8
Chest circumference	160	94.1	5	2.9	3	1.8	2	1.2
b/ Girls								
Body weight	128	75.3	6	3.5	17	10.0	19	11.2
Body height	105	61.8	13	7.6	49	28.8	3	1.8
Chest circumference	147	86.4	9	5.3	4	2.4	10	5.9
Biiliac diameter	155	91.2	–	–	2	1.2	13	7.6

Results

No far-reaching conclusions can be drawn from the mentioned figures in respect to the somatic character means regarding the students living at the settlements of different size.

The means show slight increase in the tendency of the larger settlements in case of the body height of the girls, for example, nevertheless, in the case of body weight concerning the age group of 13–15.5 years, the means for the girls grouped into the (2) settlement size are the highest. Only minimal differences could be determined graphically between the means of chest circumference on normal breathing, especially from 14 years of age. Only a slight degree deviations in body measurement means for boys could be observed on the column-diagrams.

The results of the t-test control, however, provide a higher amount of information.

In respect to the boys, as the result of the comparisons performed for the three characters (body height, body weight, chest circumference on normal breathing), from 510 cases it was statistically proved only in 70 that the body measurement means in a given age group of the boys living at larger settlements are confirmatively higher. This means 13.7% of the cases.

Four characters were taken as a base in the case of the girls verifiable differences concerning biiliac diameter could only be determined in two out of the 170 cases.

This shows that the change in this secondary sex characteristic has no connection with the size of the settlement the studied student lives at.

Taking the three characters studied for boys as a basis, verifiable higher mean to the benefit of the students living at larger settlements was demonstrated in 98 cases in respect to the girls. This meant 19.2% of the total cases.

Accordingly, all these refer to the fact — at least in the case of the 10–18 years old youth — that the body height, body weight and chest circumference on normal breathing means concerning the students living at larger settlements are averagely higher only with 16.4% taking both sexes as a basis and thus considerable relationship cannot be demonstrated between the size of the settlement and the physical development of the students living there.

Naturally, this does not mean that the effect of the settlement size is regarded to be less important in the case of the students younger than 10 years. It is feasible that the probable retardation manifest in the development of the children under 10 years of age living at smaller settlements is stopped by the peak hight velocity and thus essential differences can be observed in their case compared to the rest of the students during the course of puberty.

All these experiences give evidence of the fact that the determination of the level of physical development is necessary at certain intervals, since the social development, the changes in living standards and living conditions of a population imply modifications in the physical development of the juvenile population living there as well. At the same time, these observations also call attention to the fact that there may be changes in the degree of the effect of the environmental factors brought into connection with body growth, too.

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FURTHER TREPHINED SKULLS IN HUNGARY (CASE-HISTORY)

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Abstract

The main reason for trephination appears to be the treating of wounds but it was designed to cure mental disorders, too. The other reason was a ritualistic: a post-mortem removal of circular pieces of skull. The majority of trephined skulls from our collection is published and in this paper we present only some further trephined skulls.

Key-words: traumatic lesion, trephined skull, surgical and cultical trephination

Introduction

From paleopathological point of view the trephination represents the traumatic lesion, as a bone wound in the skull caused by sharp instrument (STEINBOCK, 1976; ORTNER and PUTSCHAR, 1981; PERROT, 1982).

Trephination (otherwise known as trepanning) is a practice known since very early times. The first example was identified by BROCA in 1867, in a Peruvian skull (HART, 1983).

Trephined crania have been in many parts of the world (the ancient examples of trephination number are well over 1000) but the greatest number occurs in two areas: Europe and South America (DERUMS, 1979; OAKLEY et al. 1959; PIGGOTT, 1940).

The main reason for trephination appears to be the treating of wounds (in association with skull fracture), although it was designed to cure epilepsy, madness, convulsions, mental disorders, too. In these cases the trephination was a surgical procedure to correct some serious medical problems therefore they removed a portion of the skull (PIGGOTT, 1940).

The other reason for the trephination was ritualistic, a post-mortem removal of circular pieces of skull; this view is supported the fact that amulets were prepared from discs of human skulls. This is the case of cultical trephination.

In the paleoanthropological material the question arises if the cutting was done before or after death. That is, whether we confronted with the product of a surgical procedure or with a result of some post-mortem ritual (cultical trephination). If signs of healing are present, the cutting is a result of a surgical trephination. It is possible,

however, that the patient died during the operation or soon after it. In this case the surgical trephination can't be distinguished from post-mortem ritual removal (cultical trephination).

The third type of trephination is the so called symbolic one which is characteristic among Hungarian tribes in the 10th century. They did not remove a portion of the skull, only scratched the tabula externa. We cannot know the exact reason or at least a ritualistic reason for the operation.

Case-history

The majority of trephined skulls from our collection (Attila József University, Szeged) is published (BARTUCZ, 1966; FARKAS, 1975; LIPTÁK, 1968; LIPTÁK and MARCSIK, 1971).

Further trephined skulls are the following:

1. Biharkeresztes–Ártánd–Nagyfarkasdomb (4th century, grave 43, female, Adultus)

The intervention was made slantly in circular form (5x5 cm) in the occipital region. The speciman survived, the edge of the cutting is very smooth. The operation of this case could be done over the sutura lambdoidea (Fig.1).

2. Sárrétudvar (10th century, grave 179, male, Maturus)

The form of cutting is „plum"-like, the larger diameter is 2.5 cm and the smaller one is 1.5 cm in the frontal region. The cutting was askew. We think that the hole

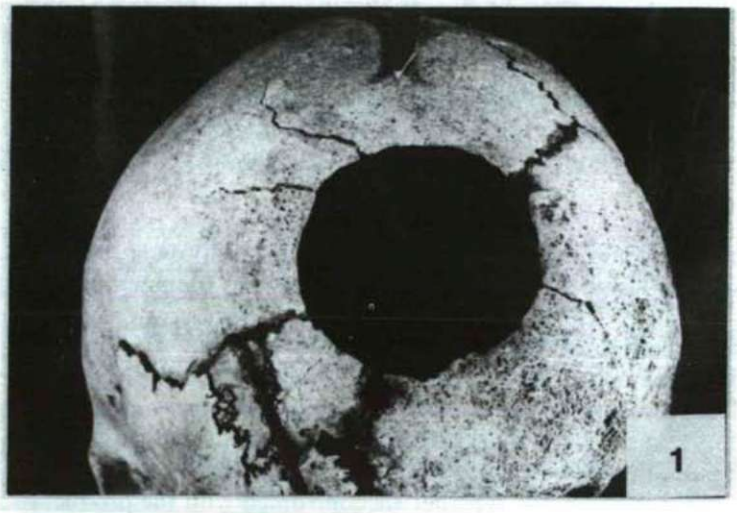

Fig. 1: Biharkeresztes–Ártánd–Nagyfarkasdomb
(4th century, grave 43, female, Adultus) surgical trephination

is a result of a mechanical intervention but the trace of rodent's teeth can also be seen everywhere. We cannot know that the specimen survived the operation or not (Fig.2).

3. Kiskőrös Város alatt (Avar period, grave 161, Juvenile, female) (Fig.3).
4. Kiskőrös Város alatt (Avar period, grave 183, male, Adultus) (Fig.4).

The last two skulls show a circular hole in the occipital region (diameter is 1 cm). They were found in the same cemetery, the intervention seems to be the same taking place in steep direction. No reaction is present on the edges. This kind of ephination can't be distinguished from post-mortem ritual removal (cultical trephination) in archaeological material. We suppose that these skulls represent cases of the cultic trephination (the holes are very small and they are in an unusual region) but this cannot certainly be proved.

In all four cases the intervention may have been preformed with the aid of a sharp instrument.

Fig. 2 : Sárrétudvar
(10th century, grave 179, male, Maturus) surgical trephination

Fig. 3 : Kiskőrös Város alatt
(Avar period, grave 161, Juvenile, female) cultical trephination?

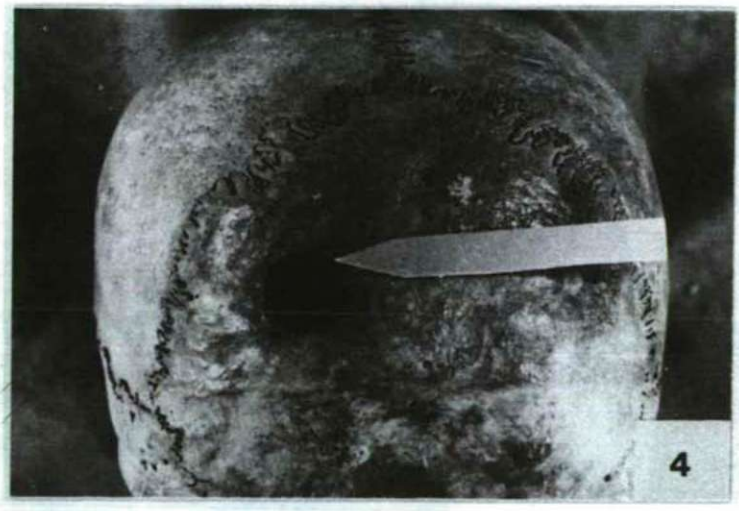

Fig. 4 : Kiskőrös Város alatt
(Avar period, grave 183, male, Adultus) cultical trephination?

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SHORT COMMUNICATIONS ON THE PROBLEMS OF THE EXINE NOMENCLATURE

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„The need and importance of establishing a simple, stringent and unambiguous terminology in palynology has lately attracted a great and renewed interest". (NILSSON, 1978, p. 189). Some years earlier, in 1975 at the meeting of the working group „Pollen morphology and numericlature" several concepts and proposals were discussed, and the important admitted resolutions are as follows; p. 87: „Layer: Regardless of the instruments used, the term nexine is retained in the cases where it is impossible to distinguish 2 strata, sole (=foot-layer, nexine 1, pedium) on one side, endexine (=nexine 2) on the other."

„Stratum: 1/ Tectum is preferred to tegillum. 2/ Infratectum may be used whatever structure this stratum shows: alveolar, granular, columellar (columella is preferred to baculum regardless of the existence of a tectum or not). 3/ Sole is preferred to foot-layer. pedium, nexine 1." The original proposal of the present writer was the following: KEDVES 1975, p. 71: „Ectexine: 1. tectum 2. infratectum (bacules, columellae, granules) 3. pedium (sole, foot layer, Basalschicht) Endexine". Other important thing to be mentioned about the admitted resolution; p. 87: „The use of the prefixe 'micro' in order to describe details exclusively visible in the electron microscope is rejected." In Lucknow, at the IV. I.C.P. a symposium of palynological terminology was held. NILSSON (1978) summarized the problems of the nomenclature of sporoderm as follows, p. 190: „Exine (pollen) — Exospore (*Pteridophyte* spores) Intine (pollen) — Endospore (*Pteridophyte* spores), Composite tectum, Structurate tectum, Infratectum, Pedium." NILSSON and MULLER (1978), p. 57: „Terms with definitions and concepts recommended in Paris, 1975" "1. Columella, f. (plur. columellae) 2. Ectexine 3. Endexine 4. Exine 5. Infratectum, n. (plur. infratecta) 6. Intine 7. Layer 8. Nexine 9. Sexine 10. Sole (foot layer) Lat. solum, n. (plur. sola) (pedium not recommended; Pedius = roman family name) 11. Sporoderm 12. Stratum, n. (plur. strata) 13. Tectum, n. (plur. tecta) (complete, partial and absent) 14. Wall

Terms not recommended 1. Atectate 2. Baculum, n. (plur. bacula) 3. Endexine s. lat. and s. str 4. Micro- 5. Muritectate 6. Nexine-1 7. Pedium (cf. Pedius) 8. Semitectate 9. Subtectate 10. Tectate"

Finally, the aim of this short compilation is that unfortunately these basic recommendations and solutions are seemingly not sufficiently wide-spread among palynologists.

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EXPLOSION OF POLLEN GRAINS UNDER THE ELECTRON BEAM EFFECT OF THE SCANNING ELECTRON MICROSCOPE

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The scanning electron microscope technique made it possible to demonstrate several surface ornamentations of biological objects, too, which could not be investigated by the light microscope method. But some problems were pointed out concerning the SEM method. We should mention: MUIR and RAMPLEY (1969) studied the effect of the electron beam on various mounting and coating media, and wrote as follows; p. 145: „The purpose of the experiments was to determine the extent of the damage, if any, produced by the beam, on the adhesive, and to try to discover the most damage resistant combinations." LEFFINGWELL et al. (1970): „The use of polyurethane adhesive-coated coverslips permits visual observation throughout the mounting procedure, and significantly reduces the charging effects obtained when specimens are mounted on coverslips without a substrate." Several problems of techniques were discussed by LEFFINGWELL and HODGKIN (1971). HANKS and FAIRBROTHERS (1970) pointed out; p. 886: „The effect of various preparation techniques differ from species to species." NILSSON et al. (1974) studied experimentally the collapse of pollen grains in scanning electron microscope.

During our SEM studies on recent and fossil spores and pollen grains we observed several times the fly away and the explosion of our objects of investigation. This may be in consequence of the charging. By increasing the accelerating beam voltage the explosion of the pollen grains may increase. From 20 KV we have increased gradually the accelerating beam voltage and the number of the exploded pollen grains increased. After this procedure we studied by LM method the slide and we observed several types of damage and explosion. Our figure demonstrates the explosion of the pollen grains of the recent *Eucommia ulmoides* OLIV.. The dried pollen grains were mounted on polyvinilchlorid adhesive, and coated with gold palladium. The explosion process is a little similar to a „microscopic supernova" and it may be presumed, that under charging and during the acceleration of the fly away explode the pollen grain.

Because we have observed other kind of damages of the palynomorphs after SEM studies we call attention of the palynologists for the LM studies of the palynomorphs after SEM investigations.

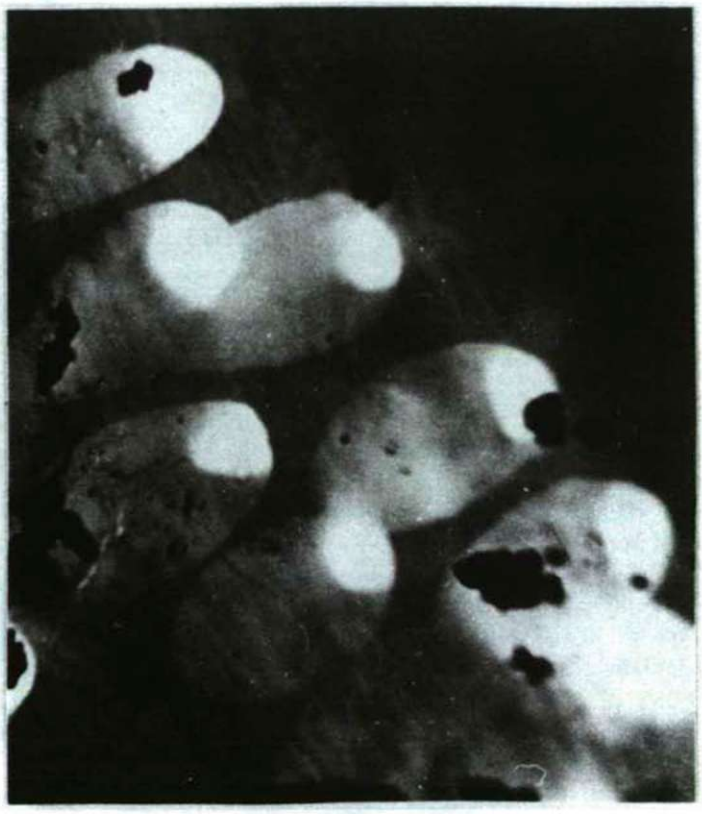

Fig. 1

LM picture of the coated polyvinilchlorid adhesive after the explosion of *Eucommia ulmoides* OLIV. pollen grains under the electron beam effect of the scanning electron microscope. x1000.

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INVESTIGATIONS ON THE MICROSCOPIC PLANT REMNANTS AND THE RADIOACTIVE ELEMENT CONTENTS OF SOME MUD SAMPLES OF THE HUNGARIAN PLAIN

M. KEDVES and T. SZEDERKÉNYI

(Received: April 23, 1985)

In our previous short communication we published (1985) our results about the dark coloured plant, firstly xylem remains, and the radioactive material content of the mud of the Lake Vadkert. But a problem remained whether there was a veritable and of universal validity connection between this two phenomena. We continued further controlling studies. One part of the samples was collected near Szeged, in this way these results may be useful in the realization of the medicinal water program of this town. Material: River-side mud samples from the Lake Sziksóstó (Dorozsma); 5/5, 5/1, 5/2, 5/3, sample from the mud of the canal near the lake — 5/4 -, and from the sodic marsh -2/1 — near the canal.Dr. G. GYULAI collected samples for our investigations from the mud of the backwater of the River Tisza; Tiszaalpár–1,3, Tőserdő–2, swamp, Bokros–4,5,6. The personnal communications of I. BAGI, and E. SZALMA about the recent vegetation of the latter mentioned localities are very useful in respect of the pollen content of the mud samples. The analyses of the radioactive elements were made by I. VADOS (Pécs, MÉV). Results, in PPM: Dorozsma–5/3 = U > 5, Ra > 5, Th: 5, K > 0.5; Dorozsma–2/1 = U > 5, Ra > 5, Th: 5, K > 0.5; Tiszaalpár–1 = U > 5, Ra > 5 Th: 4, K > 0.5; Tiszaalpár–3 = U > 5, Ra > 5, Th: 6, K > 0.5.

So, the radioactive material content of the different localities are essentially the same. But the organic material content, and in connection with this the conditions of preservations are also different. In the samples of the Lake Sziksóstó (Dorozsma) the pollen content is very poor, but in some cases the preservation is excellent, e.g.: *Cyperaceae* (fig. 1, prep. Dorozsma–5/3–1), *Typha* (fig. 2, prep. Dorozsma–5/4–3). The occurrence of the dark colored xylem remains (fig. 7,8) and the other non-colored tissue (fig. 5,6) and fungal remains is abundant (fig. 4 = *Mycophyta* conidangium, with *Tytthodiscus*-like wall structure). The above mentioned characteristic features indicate a very high biological activity. The presence of the genus *Pseudoschizaea* is worth mentioning in all investigated localities (fig. 3, prep. Tőserdő–2–2). The samples of the backwater of the River Tisza are generally rich in pollen grains, the most important palynological characteristic features are as follows: Tiszaalpár–1 = *Gramineae* dominance, Tiszaalpár 3 and Tőserdő–2 = *Gramineae* and *Salix* pollen grains are abundant. In sample Bokros–4, the *Chenopodiaceae*, *Gramineae*,

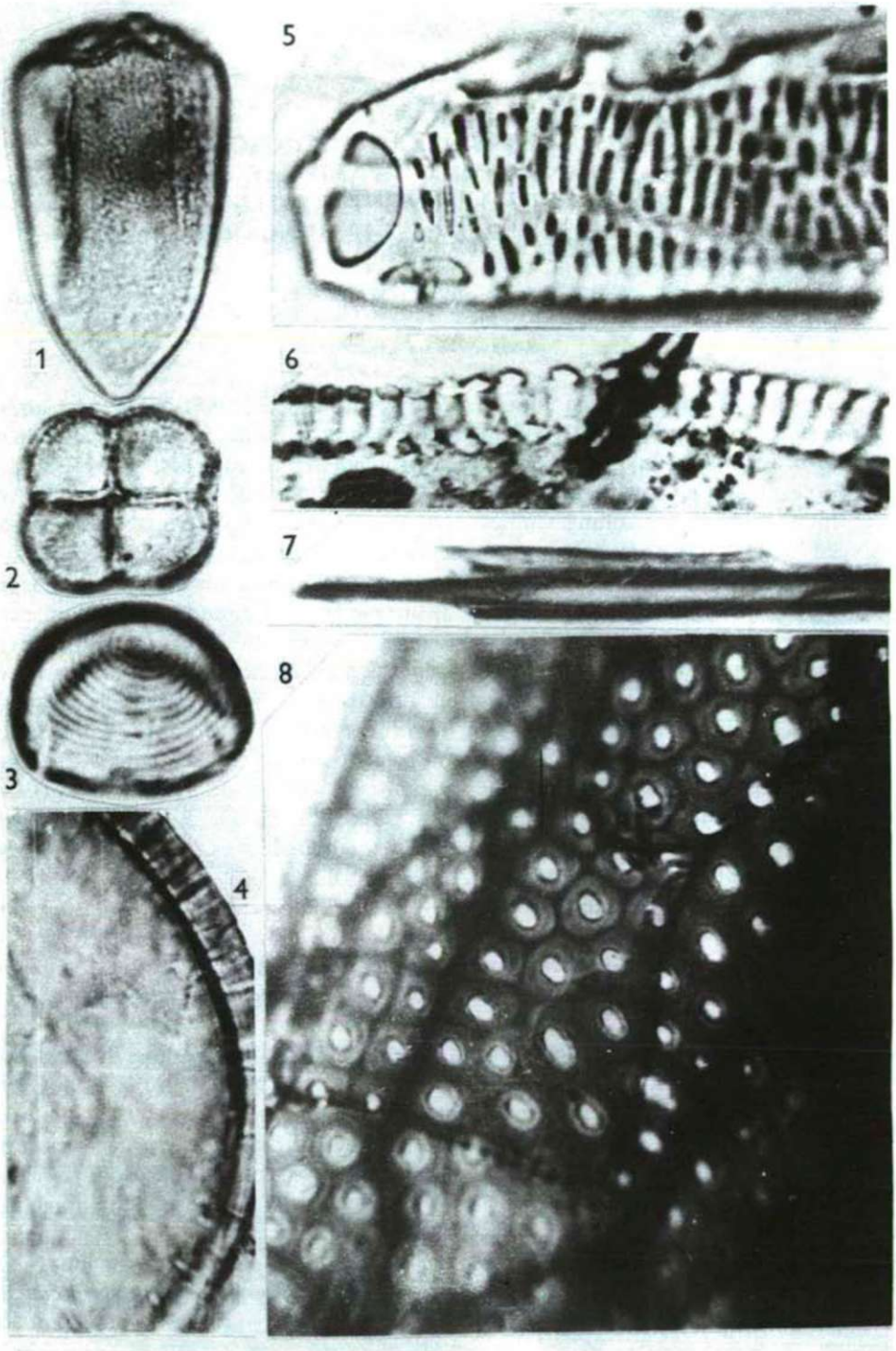

Fig. 1—8.

and *Ambrosia* in the sample Bokros–5, *Typha*, *Ambrosia* and *Gramineae*, and in the sample Bokros–6 the pollen grains of *Ambrosia* and *Gramineae* are abundant. The conditions were generally advantageous for the preservation of the organic material. On the basis of our present data it may be conclude, that the different conditions of the sedimentations don't influence the quantity and quality of the radioactive elements, they are in connection with the rebedded xylem remains, as it has been emphasized several publications.

In comparison our present data with those of the Lake Vadkert, we must emphasize, that the quantity of the radioactive elements in the samples of the present investigations is much less. The reason of this is the considerable sediment-dilution with quicksand. Whether the investigated mud is suitable for therapeutical purposes can be decided only by physician of this field of researches.

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HISTOCHEMICAL DETECTION OF VALEPOTRIATES IN THE STORAGE ROOT OF THE VALERIAN *(VALERIANA OFFICINALIS)*

E. MIHALIK and J. BERNÁTH

(Received: November, 1985)

The valepotriates, the compounds producing the sedative effect of valerian extracts, are formed in the underground organs of *Valeriana officinalis* (roots, rhisome). Their distribution within the root is debated. Valepotriate accumulation was experienced in the intercellular of the primary cortex and in pith parenchyma by BERNÁTH et al. (1973) and in the surface cells of the cortex by VERZÁR–PETRI (1971) and VIOLON and VERCRUYSSE (1982) respectively.

In our studies the valepotriates were demonstrated in cross sections prepared from the storage roots of the *Valeriana officinalis* ssp. *sambucifolia*, using DNPH acetic acid-hidrochloric acid reagent (VERZÁR–PETRI 1979). The roots were collected from two growing places (Szeged and Budakalász) in October. The sections were prepared directly following collection from the central part of the primary roots of shoot origin. The studies were repeated throughout three successive years (1983–1985).

Intensive blue staining was experienced in the subhypodermal layer of the cortex (2–5 cell rows), (Fig. 1 A). Valepotriates could not be demonstrated in the central cylinder and intercellulars, respectively. It is noteworthy that the cortex of the developing lateral root contained a considerable amount of valepotriates even at the area within the primary root (Fig. 2 A), at the same time there was also an increase of the effective compounds in the cortex cells located beside the young lateral roots far from the surface (Fig. 2 B).

As the valepotriates are situated within the roots, can be supposed that the content of effective compounds is more proportionate to the root surface, and in slighter degree to the root mass. On this basis the structural base of the greater valepotriate production is the rankly branching root system with large surface.

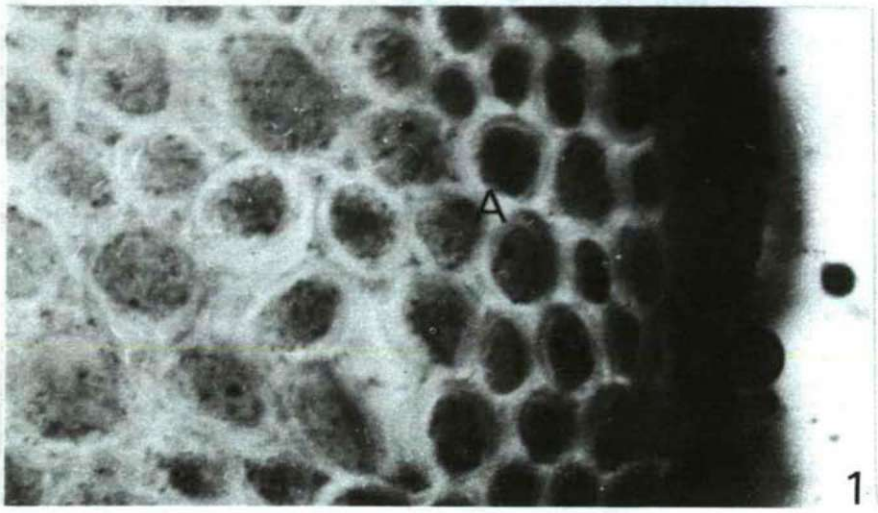

Fig. 1. The cortex of the storage root of *Valeriana officinalis*.
A = The valepotriate-containing subhypodermal layer

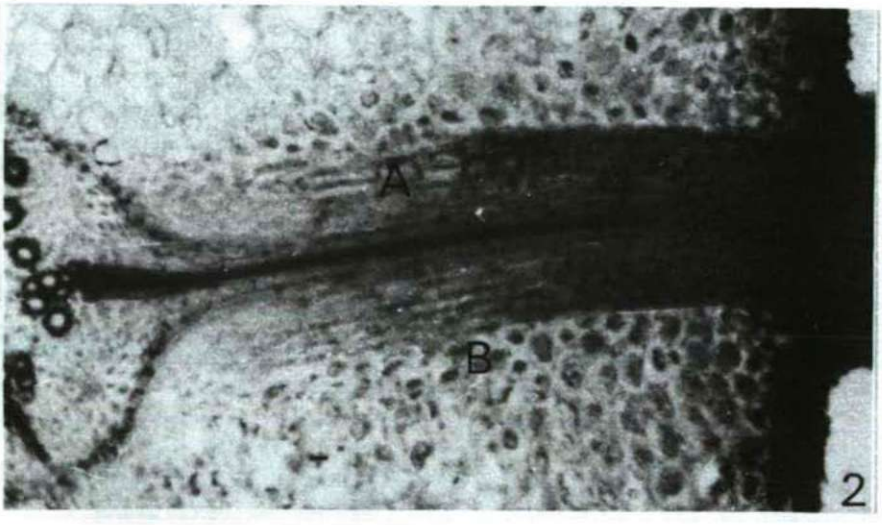

Fig. 2. Young lateral root.
A = cortex of the lateral root, B = valepotriate containing cortex cells of the primary root.

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CHRONICLE

1985

Jubilee

On the 10th anniversary of the Department of Biochemistry chair-holder professor, Dr. László Boross hold a lecture on commemoration in the Committee of Academy in Szeged.

A memorial was dedicated on the occassion of a hundreth year anniversary of the birth of professor Dr. Lajos Bartucz at the Department of Anthropology on 30. March, 1985. The opening speech was held by professor Dr. Mihály Bartók, the Dean of the Faculty of Natural Sciences and the inaguration address was held by lecturer Dr. Gyula Farkas, the chair-holder of the Department of Anthropology. On the same day a memorial was dedicated and a commemorative exhibition was opened at Szegvár, the native village of professor Dr. Lajos Bartucz. On April 1st a memorial was dedicated at the Department of Anthropology of the Lóránd Eötvös University in Budapest and a series of scientific session was held at the Hungarian Academy of Sciences.

Appointment

Dr. László Orosz, the chair-holder of the Department of Genetics, has been appointed to a university professor by the Council of Ministers.

Dr. Antónia Marcsik has been appointed to a lecturer of the Department of Anthropology by the Minister of Cultural Affairs.

Dr. Ferenc Zsoldos, university professor has been deputed to direct the work of the Department of Plant Physiology by the Minister of Cultural Affairs.

Award

Professor Dr. Lajos Ferenczy, the chair-holder of the Department of Microbiology was awarded a State Prize for his outstanding scientific work.

Retiring

Dr. S. Erzsébet Köves, lecturer, the chair-holder of the Department of Plant Physiology was retired.

Varia

The Board of Hungarian Biological Society of Szeged has been reelected. The chairman is professor Dr. Ottó Fehér, the secretary is Dr. János Gausz, scientific principal contributor.

Lecturer Dr. Horst Schmidt (Anthropological Institute, Ulm, West Germany) as a guest professor hold a lecture at the Department of Anthropology. Its title was: Erbe — Umwelt-Problem bezüglich einiger normaler menschlicher Merkmale.

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